PLAN REPORT

CITY OF HARTFORD BICYCLE MASTER PLAN

FINAL REPORT

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ORIGINATOR:	M. Hull
REVIEWER:	T Faaola
AUTHORIZATION:	S. Fry
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1 EXECUTIVE SUMMARY

1.1 INTRODUCTION

The City of Hartford Bicycle Master Plan is an overall guide for the city to identify, plan, design, construct, and maintain bicycle facilities to enhance bicycle travel within the city. It is intended to make biking a safer and more convenient mode of travel while being accessible by people of all abilities. The development of this plan involved extensive input from the general public, in combination with a partner agency committee to identify and respond to issues raised by a variety of stakeholders.

The goal of this bicycle plan is to provide Hartford with the necessary tools for developing a low stress bicycle network that is beneficial for all cyclists regardless of age or ability. By developing a low stress bicycle network, the City hopes to encourage more people to choose biking as their regular mode of transportation as well as to improve conditions for those who already bike throughout the city. Hartford would like to develop a network that accommodates all cyclists of all ages and abilities, from the 8 year old to the 80 year old cyclist. Additionally, the City hopes to serve the needs of the "invisible cyclist," who represent the population of people in the city that cannot afford cars and need the flexibility offered by a bicycle.

Although the City would like to develop a comprehensive low stress bicycle network throughout Hartford, it acknowledges that there are often physical and financial constraints that may limit its ability to do so. For instance, recent studies in the field of bicycle planning have found that separated bike lanes provide the highest level of comfort for bicyclists, however physical right-of-way constraints of Hartford's existing street network will limit the ability to implement separated bike lanes in some locations. Despite these limitations, the purpose of this plan is to develop bicycle facility selection and design guidelines that will identify both what is ideal and what is acceptable in the design of Hartford's bicycle network.

The plan is both practical and aspirational and is subject to changes or deletions over time. There is no time table for the implementation of this plan but it is hoped that it will inspire support for expansion of the bicycle network both in the near term and over time.

1.2 BICYCLE FACILITY SELECTION GUIDE

A number of factors should be considered when determining the appropriateness of various bicycle facilities that can be implemented in a street network to allow safe and efficient bicycle travel. These factors include traffic volume, average motor vehicle speed, roadway functional classification, and more. This section documents the best practices in the selection of appropriate bicycle facilities for placement within a street network.

BEST PRACTICES IN BICYCLE FACILITY AND INTERSECTION SELECTION

It is important to note that urban streets are extremely complex. Any roadway treatment must be carefully evaluated and tailored to each individual situation. Sound engineering judgement and in-depth knowledge of bicycle transportation should be applied to any bicycle facility design. It should be noted that utilizing designers and engineers who bicycle is important to developing appropriate facilities. The following section summarizes the best practices in bicycle facility selection for shared road, bike lanes, protected bike lanes, and cycle tracks. The following studies, plans, and guidelines were reviewed to develop best practices for Hartford:

- *UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL HIGHWAY SAFETY RESEARCH CENTER (2002)*
- *ONTARIO TRAFFIC MANUAL BOOK 18 CYCLING FACILITIES*

- *DENVER BIKEWAY DESIGN GUIDELINES*
- *MINNESOTA DEPARTMENT OF TRANSPORTATION*
- *SEATTLE BICYCLE MASTER PLAN*
- *LONDON CYCLING DESIGN STANDARDS*

Conflicts between bicyclists and vehicles are often heightened at intersection crossings. Intersections require the provision of treatments that are responsive to the characteristics of that intersection and of the bicycle facilities approaching the intersection. As the level of protection in the bike facility increases the need for more protected intersections also goes up to provide bicyclists with a consistent and expected experience throughout. NACTO has addressed intersection needs in detail in their *Urban Bikeway Design Guide.*

BICYCLE FACILITY AND INTERSECTION SELECTION GUIDANCE

As a result of the best practice research conducted for this task, a recommended bicycle facility selection matrix was developed for the City of Hartford. The information gathered from our best practices research were tailored for its applicability to Hartford. A number of factors should be considered when determining the appropriate bicycle facility for a street. These factors include traffic volume, average motor vehicle speed, and road function classification. It should be noted, however, that there are factors that limit the City's ability to construct new bicycle facilities, such as right-of-way constraints, available funds, and maintenance costs. Thus, the bicycle facility selection matrix developed for the City of Hartford includes the following categories for the selection of facilities:

- Preferred Facilities: Preferred facilities are the recommended facility type given the conditions specific to that corridor.
- Acceptable Facilities: Acceptable facilities are allowed for application where physical conditions, cost of construction, and/or property constraints do not allow for implementation of the preferred facility type.
- Provisional Allowances: Facilities may be allowed providing improvements associated with the installation of the bike facility are expected to bring speed or volume conditions within the acceptable range.

As a result of the best practice research conducted for this task, a recommended typical intersection treatment selection matrix was developed for the City of Hartford.

TABLE ES-1 summarizes the bicycle facility selection guidelines for the City of Hartford for preferred and acceptable facilities. TABLE ES-2 summarizes the intersection treatment selection guidance for the City of Hartford.

TABLE ES-1: HARTFORD BICYCLE FACILITY SELECTION SUMMARY MATRIX: PREFERRED AND ACCEPTABLE FACILITIES

Traffic Volume (ADT)	0-4,000	4-6,000	6-10,000	10-15,000	15-20,000	20,000+
Speed (MPH)	0-24	25-29	30-34	35-39	40-44	45+
Bicycle Boulevard						
	Design to achieve 85th percentile speed of 20 mph or less					
Shared Roadway			*Acceptable*			
			Acceptable	*Provisional**		
Striped Bike Lane				*Acceptable*		
				Acceptable	*Provisional**	
Buffered Bike Lane					*Acceptable*	
					Acceptable	*Provisional**
Separated Bike Lane				*Acceptable*		
Sidepath			*Acceptable*			

**Provisional speed ranges are allowed for the selection of facilities providing improvements associated with the installation of bike facilities are expected to bring traffic speeds within the acceptable range.*

TABLE ES-2: TYPICAL INTERSECTION TREATMENT SELECTION MATRIX

Facility Type	**Combined Lanes**	**Bike Pockets**	**Bike Boxes**	**Two-Stage Left Turn Boxes**	**Protected Intersections**	**Median Refuge Islands**	**Inter-section Crossing markings**
Bicycle Boulevard					*May be provided if intersecting facility has a buffered bike lane, separated bike lane, or sidepath*		
Shared Roadway							
Striped Bike Lane	*Acceptable*						
Buffered Bike Lane							
Separated Bike Lane				*May be provided at signalized intersections*			
Sidepath							

Note: Intersection treatments identified for the bicycle facilities in this table are specific to the bicycle facility on that approach of the intersection. Intersecting bicycle facilities may require unique intersection treatments for those approaches -or- a common intersection treatment may be required for all approaches.

1.3 DESIGN GUIDANCE

This section provides the City of Hartford with a framework for the design of bicycle facilities throughout the city. The content focuses primarily on the provision of best practice design

solutions to create complete streets that are safe and enjoyable for all bicyclists regardless of age or ability. It provides a set of recommended bicycle facility design guidelines that are tailored to fit Hartford's unique street network and neighborhood environment. The design guidelines created for this manual were based on national standards as well as other bicycle facility design manuals from local jurisdictions across the country, which were tailored to meet the unique characteristics of Hartford.

BICYCLE FACILITY DESIGN

The following sections provide brief descriptions and design guidelines for a variety of bicycle facilities that would complement Hartford's existing street network. Although this section provides guidance on bicycle facility design, it is important to remember that urban streets are extremely complex and any roadway treatment must be carefully evaluated and tailored to each specific situation. Sound engineering judgement and in-depth knowledge of bicycle transportation should always be applied to any bicycle facility design.

BICYCLE BOULEVARD

Bicycle boulevards are low speed and low volume streets that have been designed to optimize bicycle travel. They typically incorporate various traffic calming treatments that prioritize the safe and efficient movement of bicyclists and may discourage through motor vehicle traffic. A key benefit of bicycle boulevards is the ability of these facilities to offer relatively low-cost solutions in redesigning streets that are safe and attractive for bicyclists of all ages. Bicycle boulevards are recommended for use on local streets with an average daily traffic of less than 4,000 vehicles per day, or must be provided with traffic diversion measures intended to reduce the traffic volume to this threshold. Bicycle Boulevards are considered low stress facilities.

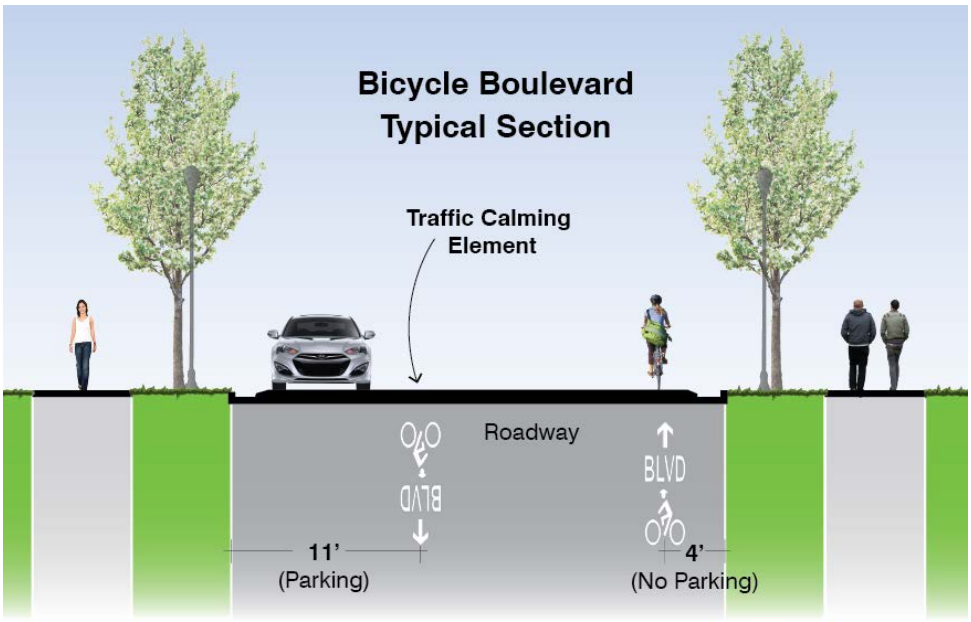

Figure ES-1: Bicycle boulevard typical section

SHARED ROADWAY

Shared road facilities allow bicyclists and motor vehicles to use the same roadway space without any separate right-of-way designations. One of the key benefits of shared road facilities is the ability to integrate a bicycle facility on a street that may not have otherwise had sufficient right-of-way to accommodate a striped bicycle lane. One of the key challenges, however, is that they do not provide improved safety for bicyclists, beyond making their presence more visible and

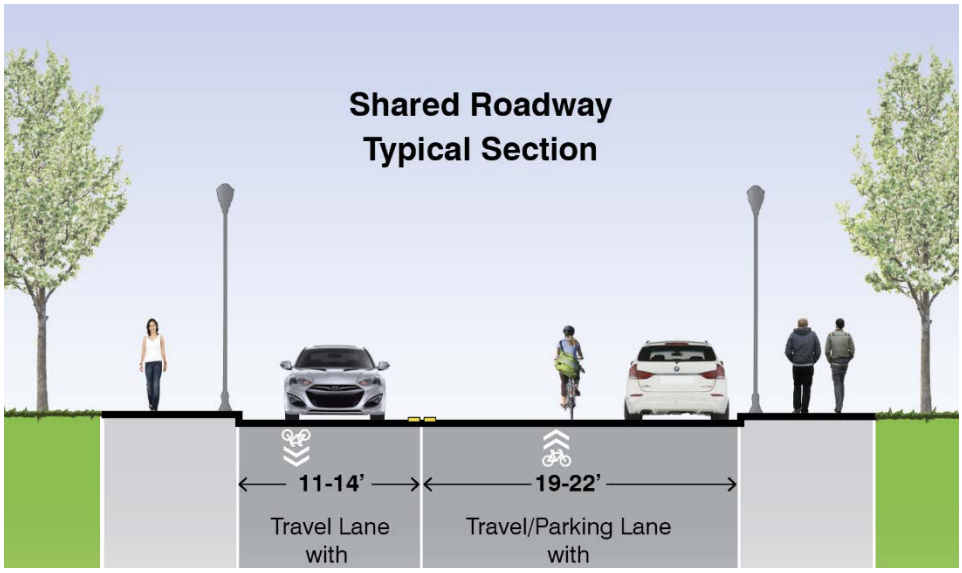

Figure ES-1: Shared roadway typical section.

expected. Shared roadways should be used where the provision of dedicated bicycle lanes or other dedicated bicycle facilities is not feasible due to geometric or right-of-way constraints.

STRIPED BIKE LANE

Striped bike lanes designate an exclusive space on the roadway for bicycle travel, which is signified by pavement markings, striping, and signage. They are typically located on the right side of the street (on a two-way street) between a motor vehicle travel lane and the curb, road edge, or parking lane. Benefits of conventional bike lanes include increasing bicyclists comfort on busy streets, designating a separate and exclusive space for both bicyclists and motorists, and improving awareness of the presence of bicyclists to drivers. Striped bike lanes are not suitable for all users as some bicyclists, especially those with less experience and confidence, do not feel comfortable riding without physical separation from traffic. Striped bicycle lanes are the most abundant bicycle facility type in Hartford currently and will likely remain the most practical accommodation in the short term for bicyclists given fiscal challenges, narrow street rights of way, and competing street uses (particularly parking).

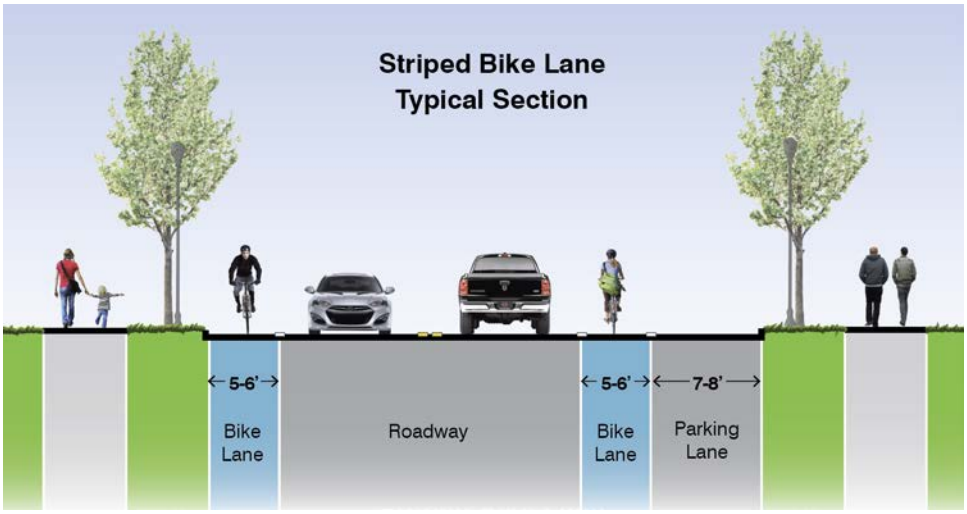

Figure ES-3: Striped bike lane typical section

BUFFERED BIKE LANE

Buffered bicycle lanes are striped bike lanes with a painted, colored, or textured at grade buffer space that is used to separate the bike lane from the adjacent motor vehicle lane and/or parking lane. This type of facility provides an improved level of comfort for the bicyclist above that provided by a simple bicycle lane by providing more space between bicyclists and motorists and more space for bicyclists to pass one another without encroaching onto the travel lane. A buffered bicycle lane is considered a lower stress facility, but does not feel comfortable to bicyclists of all ages and abilities.

The buffers typically include pavement striping and markings to alert drivers and to create a space between them and bicyclists. Buffered bicycle lanes should be used where traffic volume and/or speed requires additional separation between bicyclists and traffic so as to improve bicyclist safety and comfort. Given the space required for the bicycle lane and buffer, there are likely few corridors in Hartford that are currently suitable candidates for buffered bicycle lanes without the elimination of parking lanes, traffic lanes, or significant reconstruction of the roadway.

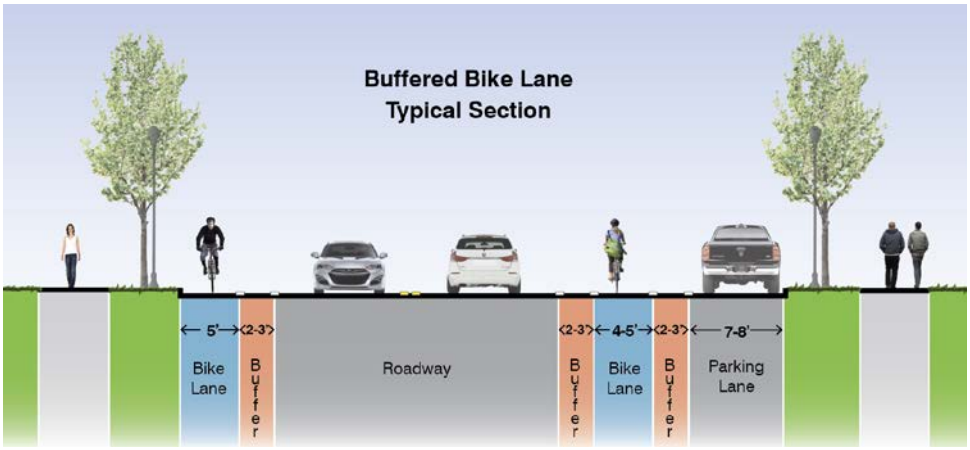

Figure ES-4: Buffered bike lane typical section

SEPARATED BIKE LANE

Separated bike lanes are physically separated from motor vehicle traffic Physical separation for separated bike lanes can include on-street parking, bollards, delineators, planters, raised medians, or raised facilities. They can be designed for one-way or two-way travel and can be at street level, at sidewalk level, or at an intermediate level between the two. Separated bike lanes are friendly to novice riders and riders of all ages because of the physical separation from traffic which is provided by a curb, landscaping, and/or other measures. Two-way separated bike lanes located on one side of the roadway may be a desirable facility where the opposing side of the roadway experiences significant turning movements such as at a highway interchange. They are also desirable where the side with the separated bike lane is not interrupted by driveways or intersections, for example, along a park or a river. Some of the key challenges of implementing separated bike lanes include high implementation costs, lack of sufficient right-of-way, the need for intersection treatments, and maintenance challenges. Separated bike lanes are considered low stress facilities.

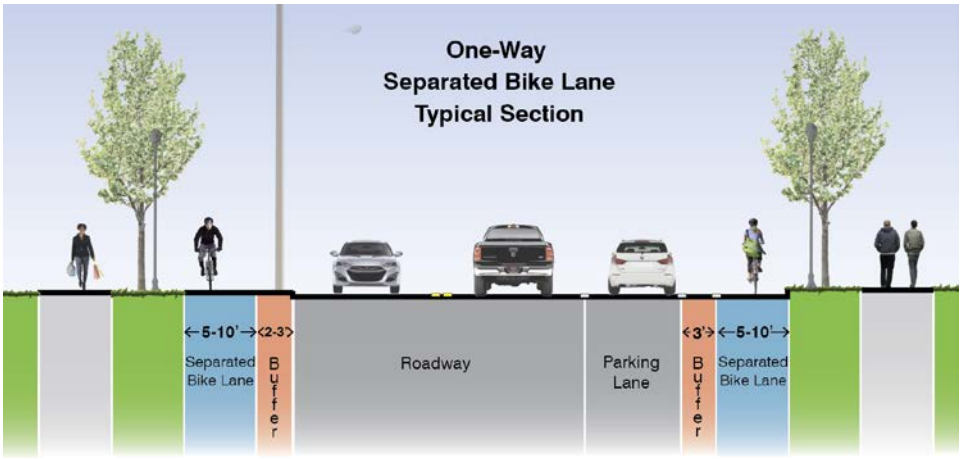

Figure ES-5: One-way separated bike lane typical section

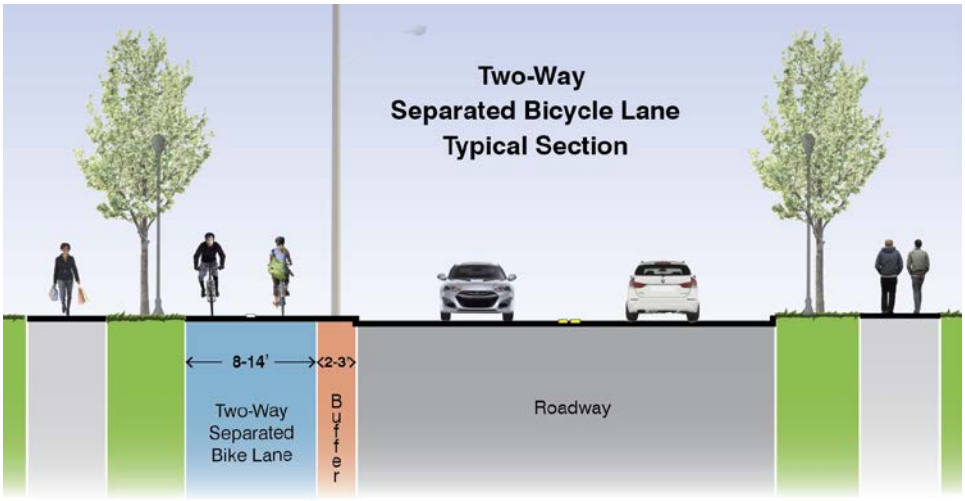

Figure ES-6: Two-way separated bike lane typical section

SIDEPATH

Sidepaths, like shared use pathways, provide a separated facility for the exclusive use of bicycles and pedestrians. These types of facilities are physically separated from motor vehicles with open space or barrier and run adjacent to the roadway. They differ from two-way separated bike lanes in that they are used by both bicyclists and pedestrians. Sidepaths often connect recreational pathways and are commonly found along the edge of parks and water features. Sidepaths may also be used to close gaps in a bicycle network created by features such as a highway interchange. Sidepaths provide significant flexibility in accommodating bicyclists because the facility can be used by both pedestrians and bicyclists in lieu of a sidewalk and on-street bicycle lanes. A side path is considered a low stress facility.

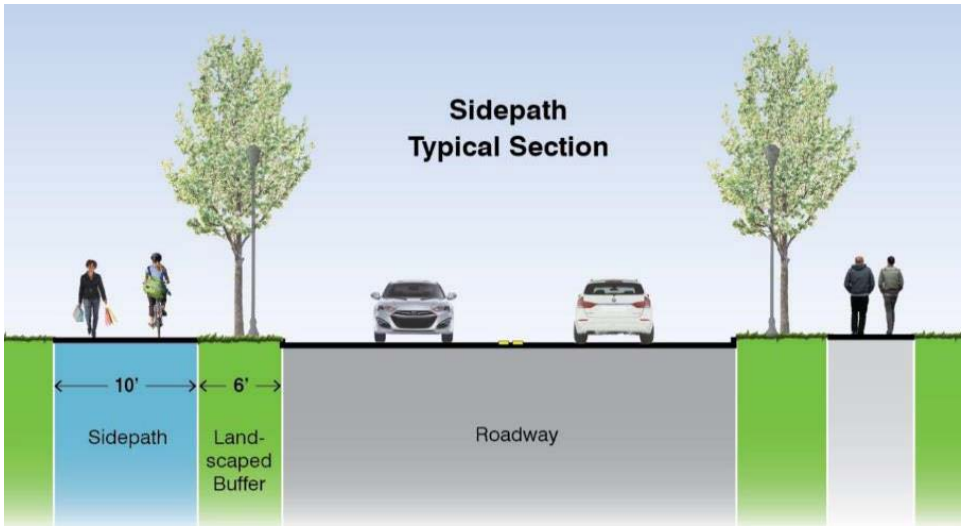

Figure ES-7: Sidepath typical section

1.4 INTERSECTION TREATMENTS

Conflicts between bicyclists and motorists are often heightened at intersection crossings. Somewhat paradoxically, higher level bike facilities, those providing greater separation between bicyclists and motorists, can lead to more conflicts at intersections. This requires improved intersection designs to help to improve safety for bicyclists by enhancing predictability in intersection approaches and crossings for all modes (bike, pedestrian and motor vehicle).

Proper intersection treatments are critical to providing a well-integrated bicycle network. Intersection treatments vary by approach facility type, intersecting facility type if present, traffic control and roadway characteristics. The treatments identified below provide solutions for most bike facility types.

COMBINED LANES

Combined lanes are used to reduce bicycle conflicts with right-turning motor vehicle traffic. Combined lanes provide markings that guide a bicyclist through an intersection along the left side of a right-turn lane. This allows through riders to travel with slower moving right-turning traffic. Cyclists making a right turn may ride at the right side of the combined lane. They create a mixing zone between the two modes. Combined lanes are recommended at intersections lacking sufficient space to accommodate a bike pocket.

BIKE POCKETS

Bike pockets are design treatments used to reduce bicycle conflicts with right-turning motor vehicle traffic. Bike pockets are placed between right-turn lanes and through travel lanes to clearly distinguish the path for bicyclists traveling straight through the intersection and motor vehicles turning right.

BIKE BOXES

Bike boxes are design treatments used at signalized intersections to provide a dedicated space for bicyclists to queue for left turns. Bike boxes help to enhance visibility of bicyclists by positioning bicyclists at the front of motor vehicle lanes to get ahead of queuing vehicles during the red signal phase. Bike boxes are a valuable tool in improving intersection navigability for bicyclists. Hartford has only a few examples of marked bicycle boxes (Broad Street has bike boxes). Bicycle boxes should be a standard facility at signalized intersections where bicycle lanes, buffered bike lanes, and one-way separated bike lanes are provided. The can also be used with shared roadways.

TWO STAGE LEFT TURN BOXES

Two stage left turn boxes (left turn boxes) are intersection design treatments that help facilitate left turns for bicyclists. They offer bicyclists a safe alternative to making left turns at signalized intersections by splitting the turning movement into two separate through movements. This type of bicycle maneuver is permitted by Connecticut state law. The maneuver eliminates the need for the bicyclist to merge over into a left lane to make a left. The design treatment involves a through movement with a bicyclist stopping in a dedicated turn box that is typically placed on the far side of the intersection to the right of a traffic or bicycle lane. Once the bicyclist arrives at the dedicated turn box, they make a second through movement to complete their left turn.

PROTECTED INTERSECTIONS

Protected intersections are an intersection design treatment that separates turning vehicles from crossing bicyclists and pedestrians with corner safety islands and setback bicycle crossings. In combination with traffic signal changes, they can improve cyclist safety in a few ways. First, they make bicyclists more visible. Second, they eliminate through bicyclist conflicts with turning motor vehicle traffic. They also provide space for left turning bicycles to position themselves for two stage left turns.

MEDIAN REFUGE ISLANDS

Median refuge islands are designed to help facilitate roadway crossings for both bicyclists and pedestrians. They provide a protected space for bicyclists to wait as they cross one direction of traffic at a time. These design treatments can also be used to help calm traffic by physically narrowing the roadway. Median refuge islands are typically used in mid-block locations where separated bike lanes, sidepaths, or shared-use pathways cross a roadway.

ROUNDABOUT FACILITIES

The accommodation of bicyclists through roundabouts requires special consideration and the type of accommodation is subject to the size (one-lane or two-lane) and design speed of the roundabout. While small, single lane, low volume roundabouts are generally favorable to bicyclists due to low traffic speeds and low volumes which provide ample gaps in traffic, higher volume single lane roundabouts and larger, higher speed, multi-lane roundabouts require a side path or separated bike lane to safely and comfortably accommodate bicyclists through the intersection.

BUS STOPS

Although transit and bicycling are often considered complementary modes, their coexistence on roadways can present a significant challenge. Conflicts between the two modes typically arise due to their differences in size, average speed, stopping patterns, and competition for curb side space. The 2012 AASHTO Guide for the Development of Bicycle Facilities provides some design guidance for the striping of bike lanes along roadways with near-side and far-side bus stops.

STREET PARKING

Bicyclists often experience conflict with on-street parking when car doors suddenly open as passengers exit. Consideration should be given to minimizing this conflict between bicyclists and parked vehicles. When possible, a buffer is recommended to be provided between the on-street parking lane and the bicycle lane to guide bicyclists away from car doors.

1.5 EXISTING CONDITIONS AND PREVIOUS PLANS

To develop the plan, existing conditions and existing plans were examined. The research included information on the characteristics of the street network, existing bicycle facilities, transit connections, bicycle trip generators and attractors in the City, including schools, parks, major employment sites, proposed bike share stations, and neighborhood retail centers. This information provided a foundation on which to base the development of the preferred bicycle network for Hartford.

CONSOLIDATING EXISTING BIKE PLANS

Hartford had a limited number of plans that specifically addressed the need for improved bicycle facilities throughout the city. The most developed was the Capitol City Parks Guide (Parks Plan), which proposed a series of bicycle facilities through and connecting to major parks. Additional plans included Hartford's 2016 revised zoning regulations that included requirements for bicycle facilities for new development, and provided a map of streets that should be prioritized for the provisions of bicycle facilities. The Hartford Bicycle Master Plan considered these proposals in its recommendations.

BICYCLE TRIP GENERATORS AND ATTRACTORS

A "heat map" of bicycle activity generators and attractors was developed. The goal of this effort was to identify areas within the City that are likely to have a high demand for bicycle facilities. Locations mapped include high density housing, hospitals, major parks, schools, transit stations, universities and retail corridors. The generator and attractor heat map is shown in Figure ES-8.

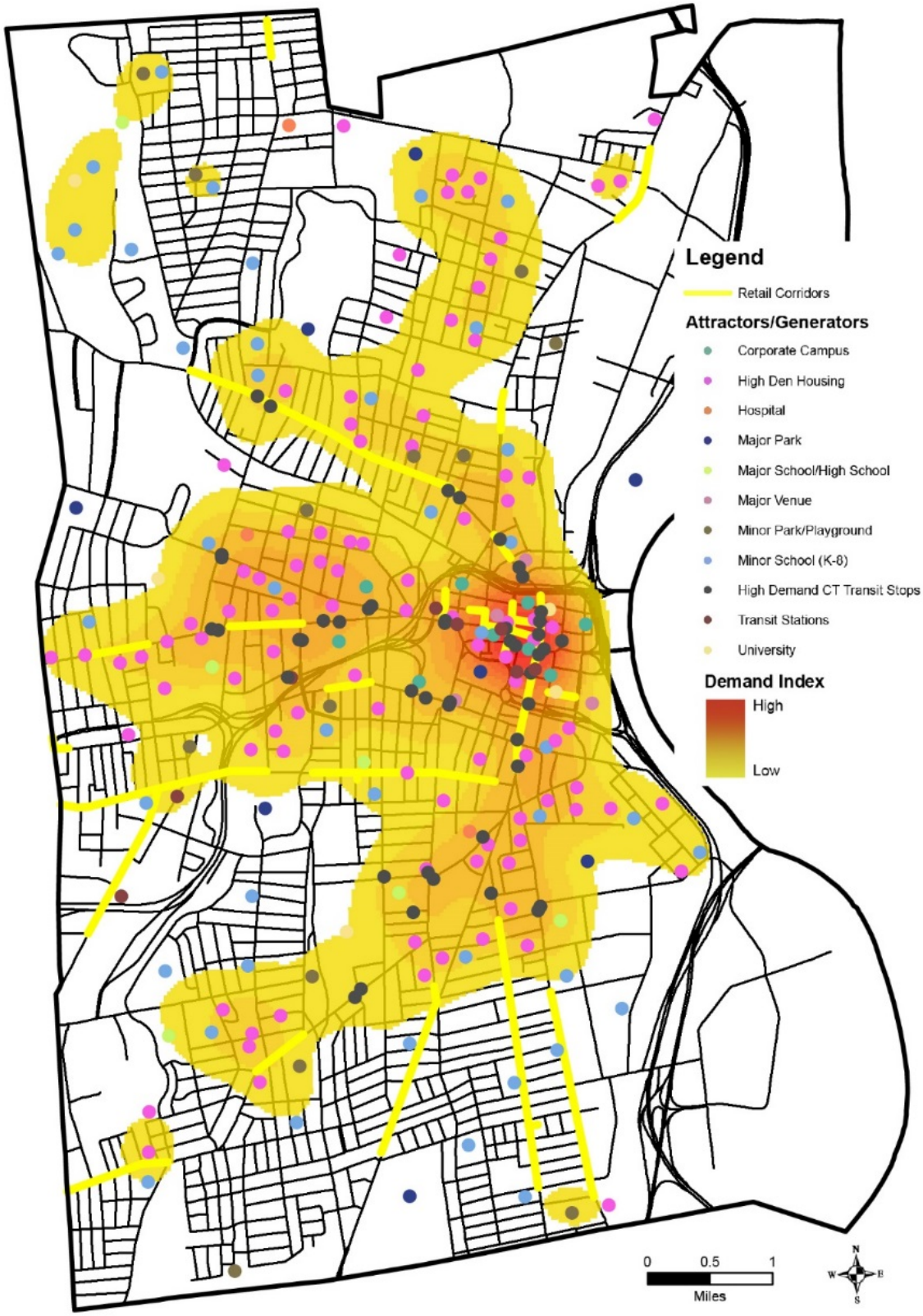

Figure ES-8: Heat map of generators and attractors.

1.6 FINAL PLAN AND RECOMMENDATIONS

The plan was carefully developed based on the needs of the City, proven techniques for the design of safe and efficient bike facilities, and input from stakeholders and the public. The goal is to eventually implement a network of bikeways that tie the entire city together giving bicyclists the same level of accessibility as motorists currently enjoy. It will create a network that is comfortable for a wide variety of bicyclists including those who are young, older, or just beginning as well as those who are more accomplished.

The resulting network provides comprehensive coverage to the entire city, to all major corridors, and all neighborhoods. As pointed out previously some corridors will be more difficult to implement than others and so will likely take more time to work through the planning and design process. Others will be fairly straightforward and non-controversial and can be completed more quickly. The recommended network is shown in Figure ES-9.

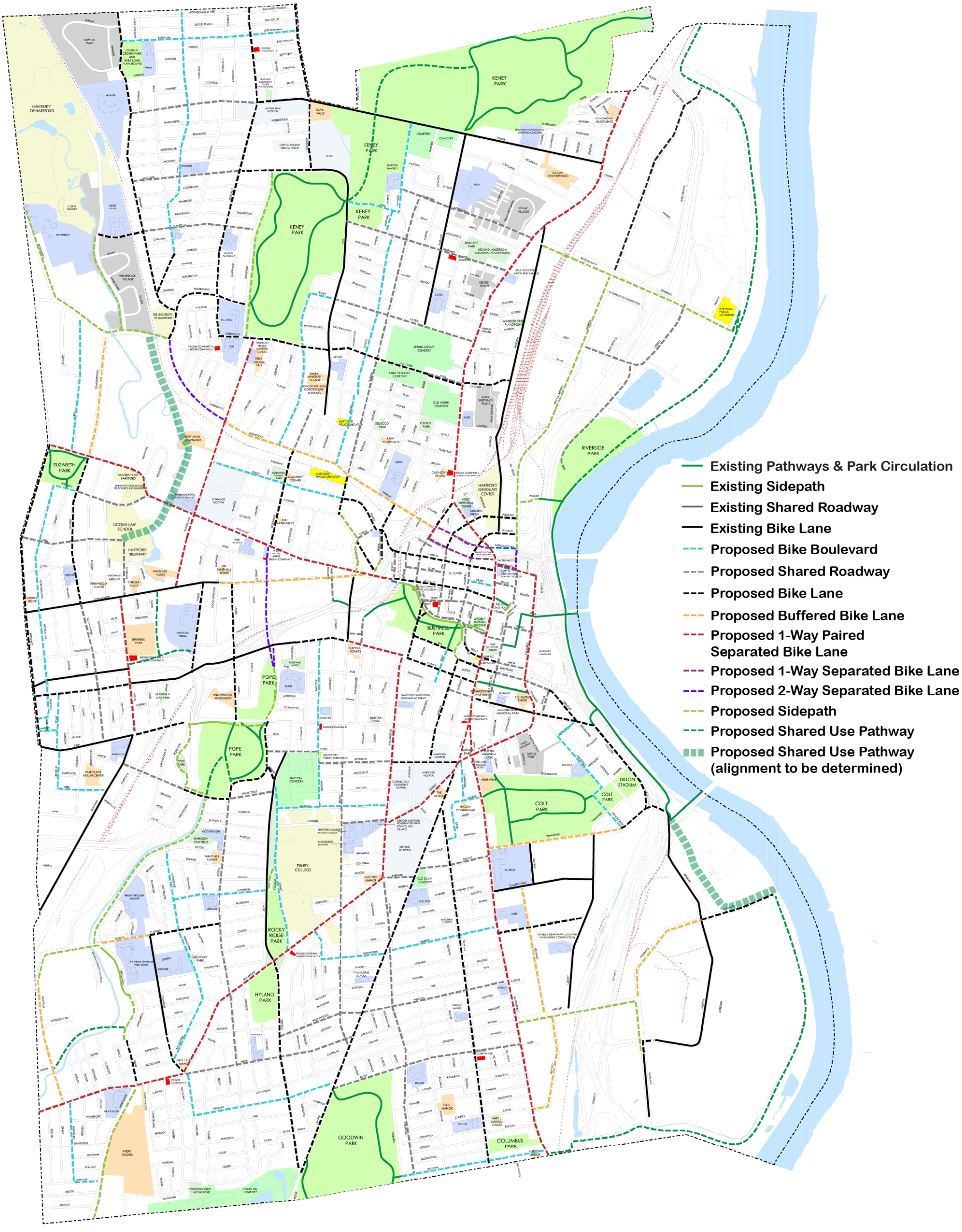

Figure ES-9: Recommended bicycle network

1.7 IMPLEMENTATION PLAN

Projects were ranked on both their benefits and implementability, to develop an overall recommendation for project phasing.

First individual projects were defined: each street that was recommended to include a bike facility was divided into sections depending upon what type of facility was proposed for each section. Some streets had just one type of facility recommended and others had two or more, depending upon how the characteristics of the street changes over its length. The type of facility selected was based on the guidelines and was usually connected to the geometry of the particular section including the number of lanes, right of way width, shoulder conditions, and other characteristics. Each project can be built discretely without limiting what can subsequently be done to either side.

The ranking included two phases, first for overall benefits and the ability to implement, and second, a combined score which assigned a phasing based upon benefits and implementability.

All of the proposed facilities were assigned a score based on the two sets of criteria: benefits and implementability. For the overall benefits criteria projects could earn scores between 0 and 24. The highest score achieved by a project was 23 and the lowest was 8. Higher scores were generally earned by longer, more extensive projects that complete key links in the bike network and that would have significant benefits for a large number of cyclists. Lower scores were generally earned by smaller, simpler projects, limited to a specific neighborhood. The benefit criteria used were:

- Mobility and Access
  - Volume of existing or potential bicycle traffic
  - Provides access to major bicycle traffic generators
  - Closes a significant gap
  - Equity
- Safety
  - Improves locations where bicycle crashes have occurred
  - Improves routes with high vehicular traffic volumes
- Regional Significance
  - Route has regional significance in the bikeway system

All of the proposed projects were also assigned a score for ability to implement based on their cost, project complexity, and whether any other challenges to their timely implementation were present. The ability to implement criteria were:

- Existing Conditions
  - Roadway able to accommodate bikeways
- Ability to Implement
  - Implementation cost
  - Additional study needed
  - Maintainability

These two scores were combined to develop a phasing score of 1 to 4, with those scored with a 1 near term, and a score of 4 being the longest term.

The report includes a list of every project considered, its benefit score, its implementability score, and its overall phasing score. Projects that score highest on benefits are shown in green, lowest in red, and those in between in yellow. The Phase 1 projects can be seen in Table ES-3 (see Section 7.2 for the full list of projects).

Table ES-3: Project list with criteria scores and ability to implement phase

Street	Proposed Facility	Length (Ft.)	Estimated Facility Cost	Low Stress?	Benefits	Implementability	Combined Score	Phase
ANN UCCELLO ST	Shared Roadway	1,790	$8,950		15	1	4	1
ARCH ST	Shared Roadway	730	$3,650		17	1	4	1
ASYLUM AV	1-Way Paired Separated Bike Lane	8,810	$925,050	X	23	3	4	1
ASYLUM ST	Bike Lane	2,560	$25,600		22	2	3	1
ASYLUM ST	1-Way Paired Separated Bike Lane	670	$70,350	X	22	3	4	1
BLUE HILLS AVE	Bike Lane	8,450	$84,500		22	2	3	1
CHURCH ST	Shared Roadway	2,560	$12,800		15	1	4	1
COLUMBUS BLVD	1-Way Paired Separated Bike Lane	4,470	$469,350	X	22	3	4	1
FARMINGTON AV	Buffered Bike Lane	3,770	$56,550		23	2	3	1
FORD ST	Shared Roadway	480	$2,400		16	1	4	1
FRANKLIN AV	Bike Lane	8,890	$88,900		18	2	4	1
GOLD ST	Shared Roadway	490	$2,450		15	1	4	1
HIGH ST	2-Way Separated Bike Lane	270	$13,500	X	15	2	3	1

Street	Proposed Facility	Length (Ft.)	Estimated Facility Cost	Low Stress?	Benefits	Implementability	Combined Score	Phase
HOMESTEAD AV	Buffered Bike Lane	3,370	$50,550		20	2	4	1
JEFFERSON ST	Shared Roadway	1,830	$9,150		15	1	4	1
JEWELL ST	Shared Roadway	1,680	$8,400		16	1	4	1
KENEY PARK	Shared Use Pathway	5,000	$600,000	X	12	3	4	1
MAPLE AV	Bike Lane	10,240	$102,400		18	2	4	1
MARKET ST	Shared Roadway	950	$4,750		17	1	4	1
NORTH CT RIVERFRONT	Shared Use Pathway	14,400	$1,728,000	X	12	2	4	1
PEARL ST	Shared Roadway	1,800	$9,000		16	1	4	1
PROSPECT ST	Shared Roadway	1,540	$7,700		15	1	4	1
SIGOURNEY ST	2-Way Separated Bike Lane	4,320	$216,000	X	15	3	3	1
SOUTH CT RIVERFRONT	Shared Use Pathway	11,650	$1,398,000	X	12	3	4	1
TRUMBULL ST	Shared Roadway	4,690	$23,450		17	1	4	1
WALNUT ST	Buffered Bike Lane	2,560	$38,400		19	2	4	1

1.8 EVALUATION PLAN

This report section documents the recommended evaluation strategy for the implementation of the Hartford Bicycle Master Plan. The evaluation strategy contains a set of performance measures and metrics that will be used by the City to evaluate the impacts on local and regional travel from implementing the Hartford Bicycle Master Plan.

The evaluation strategy for the Hartford Bicycle Master Plan includes a set of performance measures and metrics used to evaluate the impact of implementing the Plan. Each performance measure is useful for evaluating different components of the bicycle network. These performance measures include safety, facility use, network quality, connectivity and access, and financial investment. For each performance measure, a performance metric was identified. Performance metrics represent the quantitative data that will be collected and evaluated. These performance metrics include collisions/crash statistics, user counts, gap closure, facility miles, access to destinations, and expenditures on bicycle infrastructure. TABLE ES-4 summarizes the performance measures and metrics for the evaluation strategy as well as the corresponding data collection method for each. Detailed discussion on the performance measures and metrics are described in the subsequent sections.

TABLE ES-4: EVALUATION STRATEGY

PERFORMANCE MEASURE	METRIC	DATA COLLECTION METHOD
Safety	Collisions / Crash Statistics	Collisions data / crash statistics can be obtained from the University of Connecticut (UCONN) Connecticut Crash Data Repository and Hartford Police Department statistics. https://www.ctcrash.uconn.edu/
Facility Use	User Counts	Facility user counts can be collected using bicycle counters or from the Hartford Police Department traffic surveillance cameras.
Network Quality	Gap Closure	Gap closures can be identified using ArcGIS.
	Facility Miles	Facility miles can be calculated using ArcGIS.
Connectivity and Access	Access to Community Destinations (shopping centers, recreational areas, parks, etc.)	Access to community destinations can be determined using ArcGIS.
Financial Investment	Expenditures on Bicycle Infrastructure	Capital Improvement Plan, Annual Budgets

2 INTRODUCTION

The City of Hartford Bicycle Master Plan is an overall guide for the city to identify, plan, design, construct, and maintain bicycle facilities to enhance bicycle travel within the city. It is intended to make biking a safer and more convenient mode of travel while being accessible by people of all abilities. The development of this plan involved extensive input from the general public, in combination with a partner agency committee to identify and respond to issues raised by a variety of stakeholders.

Currently, only 8% of Hartford's local street network has bicycle facilities. This equates to 16 miles of Hartford's 205 miles of local streets. Most of that network, 14.6 miles, is comprised of standard bicycle lanes, while the balance includes sidepaths and sharrows. Much of this network was developed as an outcome of road diet measures. As such, many of the corridors which had capacity to accommodate bicycle lanes have already been built out. Providing bicycle accommodations on many of the city's remaining corridors will require innovative design and may require a reduction in traffic lane width, traffic lanes, parking lanes, relocation of curbs and sidewalks, and/or property easements and expansion of right-of-way. Additionally, there are few intersection treatments for bicyclists in Hartford; for example, there are only two bike boxes in the city. Intersection treatments for bicyclists are needed along existing corridors and should be incorporated along all proposed bike corridors.

The goal of this bicycle plan is to provide Hartford with the necessary tools for developing a low stress bicycle network that is beneficial for all cyclists regardless of age or ability. By developing a low stress bicycle network, the City hopes to encourage more people to choose biking as their regular mode of transportation as well as to improve conditions for those who already bike throughout the city. Hartford would like to develop a network that accommodates all cyclists of all ages and abilities, from the 8 year old to the 80 year old cyclist. Additionally, the City hopes to serve the needs of the "invisible cyclist," who represent the population of people in the city that cannot afford cars and need the flexibility offered by a bicycle.

Although the City would like to develop a comprehensive low stress bicycle network throughout Hartford, it acknowledges that there are often physical and financial constraints that may limit its ability to do so. For instance, recent studies in the field of bicycle planning have found that separated bike lanes provide the highest level of comfort for bicyclists, however physical right-of-way constraints of Hartford's existing street network will limit the ability to implement separated bike lanes in some locations. Despite these limitations, the purpose of this plan is to develop bicycle facility selection and design guidelines that will identify both what is ideal and what is acceptable in the design of Hartford's bicycle network.

The Hartford Bicycle Master Plan report is divided into nine sections.

1. Section 1 is an executive summary of the entire report.
2. Section 2 is this introduction to the plan.
3. Section 3 is a guide to selecting the best facility option for any roadway segment. It lists the various facility types included in the plan and reviews a variety of bicycle facility selection guidance from around the United States and the world. The chapter concludes with a series of matrices that guide the application of different facility types and intersection treatments to specific circumstances.
4. Section 4 is a guide to the design of bicycle facilities, both bikeways and intersections. It describes each facility type in detail and explains in what situations they would be implemented and the details in terms of position, dimensions, maintenance and other issues related to their implementation. Together, sections 3 and 4 form the policy basis for the design of the bicycle network included in plan. They will also guide any future changes or additions to the plan.

5. Section 5 describes the existing conditions research that went into laying the foundation for the development of the plan. It includes mapping of transit facilities, existing bicycle lanes, trails, and other facilities, and extensive research into activities centers, corridors, neighborhoods, and other attractors for bicycle trips in the city.
6. Section 6 describes the preferred bicycle network developed using the guidelines and existing conditions research and concludes with a map of the bicycle network.
7. Section 7 develops an implementation plan for the bicycle network taking each individual planned facility project and scoring them on their benefits to bicyclists in Hartford and then categorizing them based on their implementability.
8. The final section recommends an evaluation plan for gauging the success of the network and guiding its implementation over time.

   The plan is both practical and aspirational and is subject to changes or deletions over time. There is no time table for the implementation of this plan but it is hoped that it will inspire support for expansion of the bicycle network both in the near term and over time.

3 BICYCLE FACILITY SECTION GUIDE

A number of factors should be considered when determining the appropriateness of various bicycle facilities that can be implemented in a street network to allow safe and efficient bicycle travel. These factors include traffic volume, average motor vehicle speed, roadway functional classification, and more. This section documents the best practices in the selection of appropriate bicycle facilities for placement within a street network. Multiple studies and manuals were reviewed to provide guidance for the City of Hartford on selecting the most appropriate bicycle facility under a given set of conditions. Best practices for intersection design treatments were also reviewed. Recommendations for facilities are focused on reducing conflicts between bicyclists and vehicles. The studies and manuals reviewed as a part of this section are provided in Section 3.6 of this report.

3.1 BICYCLE FACILITY AND INTERSECTION TYPES

For the purposes of this plan, the following nomenclature for bicycle facility types is used throughout this document and is recommended for use by the City of Hartford:

Shared Bicycle and Parking Lane: Shared bike and parking lanes are marked parking lanes which have a low parking utilization rate and/or few active adjacent property uses. Shared Bicycle and Parking Lanes provide overflow parking for adjacent perpendicular residential streets or adjacent land uses such as churches, schools, or recreation facilities which have limited, but intense on-street parking needs. During periods of low parking use or restricted parking use the parking lane can operate as a de-facto bicycle lane or shoulder for bicycle use.

Bike Boulevard: Bike boulevards are low speed and low volume streets that have been designed to optimize bicycle travel. They typically incorporate various traffic calming treatments that prioritize the safe and efficient movement of bicyclists and may discourage through motor vehicle traffic. This is considered a low stress facility.

Shared Roadway: Shared roadways allow bicyclists and motor vehicles to use the same roadway space without any separate right-of-way designations. Shared roadways are delineated by “sharrow” pavement marking and share-the-road signage.

Striped Bike Lane: Striped bike lanes designate an exclusive space on the roadway for bicycle travel, which is signified by pavement markings, striping, and signage. Striped bike lanes are typically located on the right side of the street (on a two-way street) between a motor vehicle travel lane and the curb, road edge, or parking lane.

Buffered Bike Lane: Buffered bicycle lanes are conventional striped bike lanes with a painted buffer space that is used to separate the bike lane from the adjacent motor vehicle lane and/or parking lane. For this document, we are defining buffered bike lanes to be buffered with a painted buffer, and no physical separation of any kind. A shallow rumble strip may be added along the left edge of the buffer striping as an added warning to motorists. This is considered a lower stress facility, but may not be comfortable for cyclists of all ages and abilities.

Separated Bike Lane: Separated Bike Lanes (also known as cycle tracks or protected bike lanes) are bicycle lanes that are physically separated from motor vehicle traffic. Physical barriers may include on-street parking, bollards, planters, delineators, raised medians, or grade separation via a curb. Separated bike lanes can be designed for one-way or two-way travel and can be at street level, at sidewalk level, or at an intermediate level between the two. This is considered a low stress facility.

Sidepath: Sidepaths, similar to shared-use pathways, provide a separated facility for the shared use of bicycles and pedestrians. Like sidewalks, these facilities are physically separated from motor vehicles by a curb, open space, or barrier. Unlike a shared-use pathway, these facilities

are adjacent to the roadway and are located within the right-of-way. This is considered a low stress facility.

Shared-Use Path: A shared-use pathway is a facility that is shared by bicyclists and pedestrians. These facilities are often recreational in nature and often travel through open space areas and along natural features such as riverfronts. While similar in design and function to a sidepath, shared-use pathways, as referenced in this document, are not typically located adjacent to a roadway. This is considered a low stress facility.

Conflicts between bicyclists and vehicles are often heightened at intersection crossings. Somewhat paradoxically, higher level bike facilities, those providing greater separation between bicyclists and motorists, can lead to more conflicts at intersections requiring special intersection treatments. Additionally, a higher level facility will attract more riders, especially less confident riders that appreciate the protection the facility provides. Finally, both motorists and bicycles will become accustomed to the clarity and definition that the facility provides and continuing it across the intersection will maintain this expectation. Therefore, intersections require the provision of treatments that are responsive to the characteristics of that intersection and of the bicycle facilities approaching the intersection

Intersection treatments discussed in this section include the following:

Combined Lanes: Combined lanes feature the shared use of intersection queuing lanes by bicyclists and motor vehicles. Combined lanes are delineated by sharrow markings.

Bike Pockets: Bike pockets are striped bicycle lanes between thru-traffic and/or turning lanes at intersections.

Bike Boxes: Bike boxes are used at signalized intersections to provide a dedicated space, between stopped traffic and the intersection, for bicyclists while they wait for a green light or to make a left turn.

Two-Stage Left Turn Boxes: Two-stage left turn boxes are intersection design treatments that help facilitate left turns of bicyclists. The turn box is located on the far side of the intersection to the right of auto and bicycle traffic. They offer bicyclists a safe alternative to making left turns at signalized intersections by splitting the turning movement into two separate through movements.

Protected Intersections: Protected intersections are used at signalized intersections and provide a protected signal phase for bicyclists or bicyclists and pedestrians. Protected intersections provide a bicycle queuing area off of the roadway or protected by islands.

Median Refuge Islands: Median refuge islands are designed to help facilitate roadway crossings. They provide a protected space for bicyclists to wait as they cross one direction of traffic at a time.

In addition to the facilities discussed below, a detailed matrix of intersection treatment tools and where to use them has been developed by Seattle DOT in the 2014 Seattle Bicycle Master Plan. This matrix contains a large in-depth selection of intersection treatment tools and can be found in Section 3.7 of this report.

3.2 BEST PRACTICES IN BICYCLE FACILITY SELECTION

It is important to note that urban streets are extremely complex. Any roadway treatment must be carefully evaluated and tailored to each individual situation. Sound engineering judgement and in-depth knowledge of bicycle transportation should be applied to any bicycle facility design. The following section summarizes the best practices in bicycle facility selection for shared road, bike lanes, protected bike lanes, and cycle tracks.

3.2.1 UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL HIGHWAY SAFETY RESEARCH CENTER (2002)

A study conducted by Michael King in 2002 for the University of North Carolina at Chapel Hill Highway Safety Research Center evaluated more than 20 national, state, and local bicycle facility manuals on their process for bicycle facility selection. A listing of the 20 national, state, and local bicycle facility manuals that was reviewed as a part of this study can be found at the end of this section. The manuals provided guidance on selecting the most appropriate bicycle facility type under a given set of traffic and roadway conditions, such as average daily traffic volume and speed limits. Notable manuals and resources that were evaluated as a part of the study included the CROW *Sign up for the Bike: Design Manual for a Cycle-Friendly Infrastructure* (1993), the United Kingdom Institution of Highways and Transportation *Guidelines for Cycle Audit and Cycle Review* (1998), and the United States Federal Highway Administration *Selecting Roadway Design Treatments to Accommodate Bicycles* (1994). Although King's 2002 study was conducted 15 years ago, it provides a comprehensive review of national, state, and local best practices in bicycle facility selection.

The study provides guidance for the following types of bicycle facilities:

- Narrow Lane: 9 to 12 feet wide. Cyclists would either operate in the margins or take the lane. No special provisions are provided for the cyclist, i.e. mixed traffic or share the road.
- Wide Lane: 13 to 15 feet wide. Cyclists generally can operate alongside vehicles, but may also take over the lane and bike in the middle of the travel lane. Some refer to this as a shared lane or a wide curb lane.
- Bike Lane: 4 to 6 feet wide and striped (marked). In some locations the bike lane doubles as a narrow shoulder.
- Separated Lane (inclusive of buffered bike lanes, sidepaths and shared-use paths): Anything wider than a 6 foot on-street bike lane. This includes 7 and 8 foot wide bike lanes, bike lanes with separation striping or markings (buffered bike lanes), bike lanes separated by bollards or a curb and raised bike lanes (referred to as separated bike lanes in this document), bike lanes on the sidewalk or completed separated paths (sidepath or shared use path).

It should be noted that the study was conducted during a time when buffered lanes were not given much thought in the U.S. The best practices in bicycle facility selection from these resources are summarized in Table 1.

TABLE 1: UNC CHAPEL HILL STUDY ON BICYCLE FACILITY SELECTION

REGION / MANUAL OR RESOURCE	Bicycle FACILITY	15 MPH	20 MPH	25 MPH	30 MPH	35 MPH	40 MPH
Netherlands - Ploeger, J., H. Botma, T. Michels, and C. R. O. W. Stichting. "Sign Up for the Bike: Design Manual for a Cycle-Friendly Infrastructure." (1993).	Shared Road – Narrow Lane (9 to 12 feet wide)	< 8,000 ADT	-	-	-	-	-
	Shared Road – Wide Lane (13 to 15 feet wide)	-	< 9,000 ADT	< 6,000 ADT	< 4,000 ADT	< 2,000 ADT	-
	Bicycle Lane (5 foot bike lane adjacent to an 11 foot travel lane)	-	9,000-10,000 ADT	6,000-9,000 ADT	4,000-6,500 ADT	2,000-2,500 ADT	-
	Protected Bicycle Lane w/ striped buffer or Cycle Track (Buffered Bike Lane or Separated Bike Lane)	-	> 10,000 ADT	> 9,000 ADT	> 6,500 ADT	> 2,500 ADT	All
United Kingdom – Institution of Highways and Transportation. "Guidelines for Cycle Audit and Cycle Review." (1998).	Shared Road – Narrow Lane (9 to 12 feet wide)	< 3,500 ADT	< 3,200 ADT	< 3,000 ADT	< 2,500 ADT	< 1,700 ADT	-
	Shared Road – Wide Lane (13 to 15 feet wide)	3,500-6,200 ADT	3,200-6,200 ADT	-	-	-	-
	Bicycle Lane (5 foot bike lane adjacent to an 11 foot travel lane)	6,200-10,000 ADT	6,200-10,000 ADT	3,000-8,500 ADT	2,500-5,200 ADT	1,700-11,500 ADT	< 8,000 ADT
	Protected Bicycle Lane w/ striped buffer or Cycle Track (Buffered Bike Lane or Separated Bike Lane)	10,000 - 15,000 ADT	10,000 - 15,000 ADT	8,500 - 15,000 ADT	5,200 - 15,000 ADT	11,500 - 15,000 ADT	8,000 - 15,000 ADT
United States – FHWA. "Selecting Roadway Design Treatments to Accommodate Bicycles." (1994).	Shared Road – Narrow Lane (9 to 12 feet wide)[1]	-	-	-	-	-	-
	Shared Road – Wide Lane (13 to 15 feet wide)	< 10,000 ADT	< 10,000 ADT	-	-	-	-
	Bicycle Lane (5 foot bike lane adjacent to an 11 foot travel lane)	> 10,000 ADT	> 10,000 ADT	All	All	All	All
	Protected Bicycle Lane w/ striped buffer or Cycle Track (Buffered Bike Lane or Separated Bike Lane) [2]	-	-	-	-	-	-

Source: King, Michael. "Bicycle facility selection: A comparison of approaches." (2002).

[1] Guidance for shared road – narrow lane facilities was not included as a part of the 1994 FHWA manual.

[2] Guidance for protected bicycle lane w/ striped buffer or cycle track facilities was not included as part of the 1994 FHWA manual.

3.2.2 ONTARIO TRAFFIC MANUAL BOOK 18 CYCLING FACILITIES

The Ontario Traffic Manual Book (OTM) is a series of traffic engineering and traffic control reference manuals developed by the Ministry of Ontario (MTO) for use by municipalities in Ontario, Canada. The OTM Book 18 Cycling Facilities was developed to provide guidance and promote uniformity in the planning, design, and operation of bicycle facilities. Table 2 summarizes the recommended 85th percentile motor vehicle speeds, motor vehicle volumes, and street function conditions as identified by the OTM Book 18 guidelines for various bicycle facility types. Under low speed (10 to 30 mph) and low volume (500 to 2,000 ADT), the OTM Book 18 Cycling Facilities manual recommends a shared road facility. Under moderate speed (31 to 43 mph) and moderate volume (2,000 to 10,000 ADT), the manual recommends a bicycle lane facility. Lastly, under very high speed (43 mph and over) and high volume (10,000 ADT and over), the manual recommends a protected bicycle lane or cycle track facility.

TABLE 2: OTM BOOK 18 BICYCLE FACILITY SELECTION

BICYCLE FACILITY	85TH PERCENTILE MOTOR VEHICLE SPEEDS	MOTOR VEHICLE VOLUMES (on 2-lane roads)	STREET FUNCTION
No Facility Type Required	-	Very Low Volume (500 ADT)	-
Shared Road	Low Speeds (30 to 49 km/h or 19 to 30 mph)	Low Volume (500 to 2,000 ADT)	Access Roads, Local Roads, Residential Streets, Minor Collectors
Bicycle Lane	Moderate Speeds (50 to 69 km/h or 31 to 43 mph)	Moderate Volume (2,000 to 10,000 ADT)	Access Roads, Minor Collectors, Arterials, Major Collectors
Cycle Track (Separated Bike Lane)	Moderate Speeds (50 to 69 km/h or 31 to 43 mph) High Speeds (70 to 90 km/h or 43 to 56 mph) Very High Speeds (90 km/h or 56 mph and over)	High Volume (10,000 ADT and over)	Motor Vehicle Commuter Route

Source: Ontario Traffic Manual Book 18 Cycling Facilities

3.2.3 DENVER BIKEWAY DESIGN GUIDELINES

The City of Denver is in the process of finalizing its Denver Bikeway Design Guidelines, which provides contextual guidance for bicycle facility selection based on number of travel lanes, traffic volume, and travel speeds. The document is currently under final review and has not yet been adopted. Although the Denver Bikeway Design Guidelines does provide some contextual guidance, it does not distinguish which bicycle facility is preferred or what is minimally acceptable under various roadway and traffic conditions. Table 3 summarizes the guidance for bicycle facility selection from the draft Denver Bikeway Design Guidelines.

TABLE 3: DENVER BIKEWAY DESIGN GUIDELINES BICYCLE FACILITY SELECTION

BICYCLE FACILITY	NUMBER OF LANES	TRAFFIC VOLUME	TRAFFIC SPEED
Neighborhood Bikeway (Bicycle Boulevard)	2 lanes	0 to 1,000 ADT	0 to 20 mph
Advisory Bike Lane	2 lanes	0 to 8,000 ADT	15 to 35 mph
Bike Lane	2 to 4 lanes	3,000 to 20,000 ADT	20 to 40 mph
Buffered Bike Lane	4 to 8 lanes	3,000 to 20,000 ADT	20 to 40 mph
Physically Protected Bike Lane (Separated Bike Lane)	4 to 10 lanes	3,000 to 30,000 ADT	20 to 50 mph

Note: Neighborhood bikeways are a form of shared road facility and bicycle boulevard. Advisory bike lanes are a type of bicycle lane where the lanes are dotted instead of striped and the street becomes a yield street for motorists.
Source: Denver Bikeway Design Guidelines

3.2.4 MINNESOTA DEPARTMENT OF TRANSPORTATION

The Minnesota Department of Transportation (MNDOT) has also released guidance on the selection of bicycle facilities as a part of its 2007 Bikeway Facility Design Manual. Similar to the Denver Bikeway Design Guidelines, the MNDOT design manual focuses on number of lanes, average daily traffic volumes, and average motor vehicle speed when determining the most appropriate bicycle facility. Although the design manual does provide some guidance on the selection of bicycle facilities, it excludes guidance for buffered bike lanes and cycle track facilities, making the manual less useful for the City of Hartford. The design manual provides guidance for the following types of bicycle facilities:

- Bicycle Lane
- Shared Lane (Shared Roadway): shared with motor vehicle travel lane of typically 12 feet wide or less.
- Wide Outside Lane (Shared Roadway): shared with motor vehicle travel lane between 14 and 16 feet wide.
- Shared Use Path (Including Sidepaths)
- Paved Shoulder: The shoulder is the edge or border of a roadway that is contiguous with, and on the same level as, the regularly traveled lanes. This facility is a type of shared lane, however, bicyclists are typically expected to ride along the shoulder of the roadway and do not “take the lane” as under conventional shared lane facilities. These facilities also lack the “bike lane” pavement markings that distinguish a bicycle lane from a motor vehicle lane.

Table 4 summarizes MNDOT's guidance on bicycle facility selection.

TABLE 4: MNDOT BICYCLE FACILITY SELECTION GUIDANCE FOR URBAN CROSS SEC**TION**

MOTOR VEHICLE ADT (2 LANE)		< 500	500 – 1,000	1,000 – 2,000	2,000 – 5,000	5,000 – 10,000	> 10,000
MOTOR VEHICLE ADT (4 LANE)		**N/A**	**N/A**	**2,000 – 4,000**	**4,000 – 10,000**	**10,000 – 20,000**	**> 20,000**
MOTOR VEHICLE SPEED	**25 MPH**	SL	WOL	WOL	WOL	BL = 5 ft	N/A
	30 MPH	SL w/ sign	WOL	BL = 5 ft	BL = 5 ft	BL = 6 ft	BL = 6 ft
	35 – 40 MPH	WOL	BL = 5 ft	BL = 5 ft	BL = 6 ft	BL = 6 ft	BL = 6 ft or PS = 8 ft
	45 MPH AND GREATER	BL = 5 ft	BL = 5 ft	BL = 6 ft	BL = 6 ft	BL = 6 ft or PS = 8 ft	PS = 10 ft
BL = Bicycle Lane, SL = Shared Lane, WOL = Wide Outside Lane, PS = Paved Shoulder							

Note: Paved shoulders are a form of bicycle lane and wide outside lanes are a form of shared road facility
Source: Minnesota Department of Transportation 2007 Bikeway Facilities Design Manual

3.2.5 SEATTLE BICYCLE MASTER PLAN

The 2014 Seattle Bicycle Master Plan developed by the Seattle Department of Transportation (SDOT) has provided guidance on the selection of bicycle facilities. The Seattle plan designates bicycle facilities based on posted speed limits, average daily traffic, and street classifications. According to the plan, a neighborhood greenway (bike boulevard) is recommended on roadways where the posted speed limit is 20 mph, ADT is 1,500 or less, and on non-arterial roadways. Shared streets (shared roadways) are recommended on roadways where the posted speed limit is between 25 to 30 mph, used non-arterial and collector/minor arterials. A bicycle lane is recommended on roadways where the posted speed limit is 30 mph, ADT is 8,000 or less, and on collector arterial roadways. A buffered bicycle lane is recommended on roadways where the posted speed limit is 30 mph, ADT is 15,000 or less, and on collector/minor arterials. Lastly, cycle tracks (separated bike lanes) are recommended on roadways where the posted speed limit is 30 mph or higher, ADT is 15,000 and over, and on minor/principal arterials. A summary of the guidelines can be found in Table 5 below.

TABLE 5: SEATTLE BICYCLE MASTER PLAN FACILITY DESIGNATION GUIDELINES

GENERALIZED BICYCLE FACILITY DESIGATION	BICYCLE FACILITY TYPES	POSTED SPEED LIMIT (mph)	AVERAGE DAILY TRAFFIC (adt)	STREET CLASSIFICATION
Neighborhood greenway (Bicycle Boulevard)	Neighborhood Greenway	20	1,500 or less	Non-arterial
Shared street (Shared Roadway)	Shared lane pavement parking (sharrow)	25 – 30	To be used due to ROW constraints or topography	Non—arterial and Collector / Minor arterials
In street, minor separation	Bicycle lane; Climbing lane	30	8,000 or less	Collector arterial
	Buffered bicycle lane	30	15,000 or less	Collector / Minor arterials
Cycle track (Separated Bike Lane)	Physically separated (raised or with barrier on-street facility)	30 and greater	15,000 and above	Minor / Principal arterials

Source: Seattle 2014 Bicycle Master Plan

3.2.6 LONDON CYCLING DESIGN STANDARDS

International guidance on bicycle facility selection was also reviewed. In 2014, Transport for London (TFL), the local government agency responsible for the transportation system in London, developed the London Cycling Design Standards, which provides guidance for the design of bicycle infrastructure, bicycle friendly streets, and bicycle parking for all streets in London. The 2014 London Cycling Design Standards provides some guidance on the selection of bicycle facilities as summarized in Table 6.

The London Cycling Design Standards determine bicycling facilities based on street types. Streets are categorized into nine types according to its relative significance of movement and place within an area. Movement is defined in terms of people, not vehicles, and place refers to activity and frontages adjacent to the street. Thus, arterial roads are considered low place functioning streets, while city streets are considered high place functioning streets. In locations with higher place function, the design standards focus on how the general traffic might be calmed to make the place more inviting for bicyclists and how to bring more into the space. For locations with lower place functions, such as arterial roads, the guidance recommends bicycle facilities with higher degrees of separation, such as separated bicycle lanes, to reduce conflict with motor vehicles.

TABLE 6: TFL LONDON CYCLING DESIGN STANDARDS – BICYCLE FACILITY SELECTION **GUIDANCE**

	Low Place Function (Rural)			Medium Place Function (suburban)			high place function (urban)		
	Arterial Road	Connector	Local Street	High Road	High Street	Town Square	City Hub	City Street	City Place
Full Separation on Links (Separated Bike Lane)									
Dedicated on-carriageway lanes (Striped Bike Lane)									
Shared on-carriageway lanes (Shared Roadway or Advisory Lane)									
Integration with other vehicles (No Bike Facilities)									

Source: Reproduced from TFL 2014 London Cycling Design Standards

3.3 BEST PRACTICES FOR INTERSECTION TREATMENTS

Conflicts between bicyclists and vehicles are often heightened at intersection crossings. Intersections require the provision of treatments that are responsive to the characteristics of that intersection and of the bicycle facilities approaching the intersection. As the level of protection in the bike facility increases bicyclists can be put in situations that require higher level treatments at intersections. For example, a separated bicycle lane which is to the right of the roadway, creates conflicts between bicyclists proceeding straight and right turning traffic at the same time that the bike facility and its occupants are less visible to the motorist. Providing improved intersection treatments will also provide bicyclists with a consistent and expected experience throughout. NACTO has addressed intersection needs in detail in their *Urban Bikeway Design Guide.*

In addition to the facilities discussed below, a detailed matrix of intersection treatment tools and where to use them has been developed by Seattle DOT in the 2014 Seattle Bicycle Master Plan. This matrix contains a large in-depth selection of intersection treatment tools and can be found in Section 3.7 of this report.

3.3.1 COMBINED LANES

Combined lanes feature the shared use of intersection queuing lanes by bicyclists and motor vehicles. Combined lanes are delineated by sharrow markings.

Based upon NACTO guidelines, combined lanes are typically applied as follows:

- *On streets where there is a right turn lane but not enough space to maintain a standard width bicycle lane at the intersection.*
- *On streets where there is no dedicated right turn lane, but on which high volumes of right turning traffic may cause conflicts between motorists and bicycles. This application is intended to guide bicyclists to occupy the center of the traffic lane so as to avoid a conflict with right turning drivers.*

- *On cycle track corridors where there is a dedicated turn lane on the side of the street with the cycle track, but where a separate bike signal phase is not appropriate or feasible.*
- *Combined lanes may not be appropriate at intersections with very high peak automobile right turn demand.*

Note: Connecticut law permits bicyclists traveling straight through the intersection to place themselves in the left edge of right turn lanes.

3.3.2 BIKE POCKETS

Bike pockets are striped bicycle lanes between thru-traffic and/or turning lanes at intersections.

The 2014 NACTO Urban Bikeway Design guide provides guidance on the use of "through bike lanes" which are the same intersection treatment as bike pockets. Based upon NACTO's guidelines, through bike lanes are typically applied as follows:

  - *On streets with right-side bike lanes and right-turn only lanes at intersections.*
  - *On streets with left-side bike lanes and left-turn only lanes at intersections.*
  - *On streets with bike lanes and an auxiliary right-turn-only lane added in advance of the intersection.*
- *On streets with bike lanes and a parking lane that transition into a turn lane at intersections.*

The City of Redmond also provides guidance in their Bicycle Design Guidelines. The guidelines recommend placing bike lane pockets where available lane width allows. Where there is not sufficient space for a bike lane pocket, the guidelines recommend utilizing a combined lane.

3.3.3 BIKE BOXES

Bike boxes are used at signalized intersections to provide a dedicated space, between stopped traffic and the intersection, for bicyclists while they wait for a green light or to make a left turn.

The 2014 NACTO Urban Bikeway Design guide provides the following guidance on the typical application of bike boxes and recommends their application under the following conditions:

- *At signalized intersections with high volumes of bicycles and/or motor vehicles, especially with frequent bicyclist left-turns and/or motorist right-turns.*
- *Where there may be right or left-turning conflicts between bicyclists and motorists.*
- *Where there is a desire to accommodate left turning bicycle traffic.*
- *Where a left turn is required to follow a designated bike route, access a shared-use path, or when the bicycle lane moves to the left side of the street.*
- *When the dominant motor vehicle traffic flows right and the bicycle traffic continues through (such as a Y intersection or access ramp).*

3.3.4 TWO-STAGE LEFT TURN BOXES

Two-stage left turn boxes are intersection design treatments that help facilitate left turns of bicyclists. The turn box is located on the far side of the intersection to the right of auto and bicycle traffic. They offer bicyclists a safe alternative to making left turns at signalized intersections by splitting the turning movement into two separate through movements

Guidance for the use of two stage left turn boxes is provided by the FHWA and NACTO. They are not specifically described in the FHWA MUTCD, however, in 2017, the FHWA released an interim approval for the optional use of two stage bicycle turn boxes. The FHWA provides the following use guidance for two stage bicycle turn boxes as identified in their Memorandum of Interim Approval for Optional Use of Two-Stage Bicycle Turn Boxes.

Mandatory use of a two-stage bicycle turn box by turning bicycles should be limited to those locations where physical or operational conditions make it impracticable or unsafe for a bicyclist to merge and make the appropriate turn as would any other vehicle.

In addition to guidance from the FHWA, NACTO also provides guidance on the usage of two stage bicycle turn boxes. The 2014 NACTO Urban Bikeway Design guide provides the following guidance on the typical application of two stage bicycle turn boxes and recommends their application under the following conditions:

- *At signalized intersections.*
- *Along multi-lane roadways.*
- *Along roadways with high traffic speeds and/or traffic volumes.*
- *Where a significant number of bicyclists turn left from a right-side facility.*
- *Along cycle tracks.*
- *To safely navigate streetcar tracks.*

3.3.5 PROTECTED INTERSECTIONS

Protected intersections are used at signalized intersections and provide a protected signal phase for bicyclists or bicyclists and pedestrians. Protected intersections provide a bicycle queuing area off of the roadway or protected by islands.

Protected Intersections have the following features: A corner refuge island, a setback crossing of the pedestrians and cyclists, a forward stop bar for roadway, and separate signal phasing or a shared bicycle and pedestrian phase. Protected Intersections are a preferred intersection treatment for separated bicycle lanes and sidepaths as these facilities have bicycle traffic that is separated from the roadway on intersection approaches. The provision of a Protected Intersection continues that separation through the intersection.

Protected Intersections have downsides and limitations. They require more area than a traditional intersection, may require a separate signal system and introduce more complexity to the pedestrian environment, particularly for those with visual or mobility impairments due to bike lane crossings, traffic islands, and interaction with cyclists.

The 2015 publication “Lessons Learned: Evolution of the Protected Intersection” includes case studies on the successful implementation of protected intersections in cities throughout the U.S. and Canada. These cities include Salt Lake City, Chicago, Austin, Davis, Vancouver, and Montreal. The case studies revealed that protected intersections could be implemented on a variety of street types ranging from local streets, minor collectors, and major arterials. The case studies also reveal that protected intersections could be implemented on a variety of street contexts, such as a central business district or residential subdivisions, as well as on a variety of streets with ADTs ranging from 6,000 to 20,000 ADT. Table 7 compares the different street types, traffic volumes, and bikeway types of several protected intersections.

TABLE 7: PROTECTED INTERSECTION CASE STUDY COMPARISONS

DESIGN ELEMENTS	SALT LAKE CITY	AUSTIN	DAVIS	CHICAGO	VANCOUVER	MONTREAL
STREET TYPE	Local street and minor collector	Local streets	Arterial street at neighborhood collector	Dedicated bus corridor; One-way streets	Arterial and collector	Local street and major arterial
STREET CONTEXT	Central Business District	Residential subdivision	Residential subdivision	Central business district	Bridge approach into downtown	Residential neighborhood

MOTOR VEHICLE VOLUMES	6,000 ADT on each street	Unknown	3,500-20,000 ADT	Unknown	Unknown	Unknown
BIKEWAY TYPE	One-way protected bike lanes	Two-way protected bike lanes	On street bike lanes and shared use path	One-way separated bike lane w/ one-way buffered bike lane	Two-way separated bike lane and one-way separated bike lane	Forced turn of a two-way separated bike lane

Source: Alta 2015 Lessons Learned: Evolution of the Protected Intersection

3.3.6 MEDIAN REFUGE ISLANDS

Median refuge islands are designed to help facilitate roadway crossings. They provide a protected space for bicyclists to wait as they cross one direction of traffic at a time.

The 2014 NACTO Urban Bikeway Design guide provides the following guidance on the typical application of median refuge islands and recommends their application under the following conditions:

- *Where a bikeway crosses a moderate to high volume or high-speed street.*
- *Along streets with high bicycle and pedestrian volumes.*
- *Along streets with few acceptable gaps to cross both directions of traffic.*
- *At signalized or unsignalized intersections.*
- *Where it is desirable to restrict vehicle through movements, a median can double as a diverter to prevent cut-through traffic on a bicycle route.*

3.3.7 INTERSECTION CROSSING MARKINGS

The 2014 NACTO Urban Bikeway Design guide provides the following guidance on the typical application of intersection crossing markings and recommends their application under the following conditions:

- Across signalized intersections, particularly through wide or complex intersections where the bicycle path may be unclear.
- Along roadways with bike lanes or cycle tracks.
- Across driveways and Stop or Yield controlled cross-streets.
- Where typical vehicle movements frequently encroach into bicycle space, such as across ramp-style exits and entries where the prevailing speed of ramp traffic at the conflict point is low enough that motorist yielding behavior can be expected.
- May not be applicable for crossings in which bicycles are expected to yield priority, such as when the street with the bicycle route has Stop or Yield control at an intersection.

3.4 BICYCLE FACILITY SELECTION GUIDANCE

As a result of the best practice research conducted for this task, a recommended bicycle facility selection matrix was developed for the City of Hartford. The information gathered from our best practices research were tailored for its applicability to Hartford. A number of factors should be considered when determining the appropriate bicycle facility for a street. These factors include traffic volume, average motor vehicle speed, and road function classification. It should be noted, however, that there are factors that limit the City's ability to construct new bicycle facilities, such as right-of-way constraints, available funds, and maintenance costs. Thus, the bicycle facility selection matrix developed for the City of Hartford includes the following categories for the selection of facilities:

- Preferred Facilities: Preferred facilities are the recommended facility type given the conditions specific to that corridor.
- Acceptable Facilities: Acceptable facilities are allowed for application where physical conditions, cost of construction, and/or property constraints do not allow for implementation of the preferred facility type.
- Provisional Allowances: Facilities may be allowed providing improvements associated with the installation of the bike facility is expected to bring speed or volume conditions within the acceptable range.

Tables 8 through 10 summarize the bicycle facility selection guidelines for the City of Hartford.

The recommended facility types for Hartford do not include Advisory Bicycle Lanes and Shared Bicycle and Parking Lanes. Advisory Bicycle Lanes are not recommended because they require regular encroachment of motor vehicle traffic into the bicycle lane and which may encourage drivers to encroach similar facilities such as striped bike lanes and buffered bike lanes. Shared Bicycle and Parking Lanes are not recommended as they may encourage bicyclists to operate within the door zone of parked vehicles and they suggest that parking within a bicycle facility is acceptable, which may also encourage this behavior within bicycle lanes and buffered bicycle lanes. Shared Roadways are recommended in lieu of these facility types and are likely to be an equally effective facility.

TABLE 8: HARTFORD BICYCLE FACILITY SELECTION MATRIX: PREFERRED FACILITIES

BICYCLE FACILITY	ROADWAY ADT	85TH PERCENTILE SPEED	STREET TYPE
Bicycle Boulevard	Less than 4,000*	*Design to achieve 85th percentile speed of 20 mph or less*	Local
Shared Roadway	Less than 6,000	Less than 25 mph	Local, Collector
Striped Bike Lane	4,000-10,000	Less than 30 mph	Local, Collector, Minor Arterial
Buffered Bike Lane	10,000-15,000	Less than 35 mph	Collector, Minor Arterial, Principal Arterial
Separated Bike Lane	15,000 or more	25 mph or higher	Minor Arterial, Principal Arterial
Sidepath	10,000 or more	25 mph or higher	Collector, Minor Arterial, Principal Arterial

**The limit of 4,000 ADT for Bicycle Boulevards was chosen as it coincides with the maximum traffic volume allowed for streets to be eligible for the City's speed hump program. It is anticipated that improvements associated with the implementation of bicycle boulevards will also act as a deterrent to non-local traffic thereby reducing traffic volume on the bicycle boulevard.*

TABLE 9: HARTFORD BICYCLE FACILITY SELECTION MATRIX: ACCEPTABLE FACILITIES

BICYCLE FACILITY	ROADWAY ADT	85TH PERCENTILE SPEED	STREET TYPE
Bicycle Boulevard	Less than 4,000*	*Design to achieve 85th percentile speed of 20 mph or less*	Local
Shared Roadway	Less than 10,000	Less than 30 mph *Less than 35 mph (Provisional*)*	Local, Collector, Minor Arterial
Striped Bike Lane	4,000-15,000	Less than 35 mph *Less than 40 mph (Provisional*)*	Local, Collector, Minor Arterial, Principal Arterial
Buffered Bike Lane	10,000-20,000	Less than 40 mph *Less than 45 mph (Provisional*)*	Collector, Minor Arterial, Principal Arterial
Separated Bike Lane	10,000 or more	25 mph or higher	Minor Arterial, Principal Arterial
Sidepath	6,000 or more	25 mph or higher	Collector, Minor Arterial, Principal Arterial

**Provisional speed ranges are allowed for the selection of facilities providing improvements associated with the installation of bike facilities are expected to bring traffic speeds within the acceptable range.*

TABLE 10: HARTFORD BICYCLE FACILITY SELECTION SUMMARY MATRIX: PREFERRED AND ACCEPTABLE FACILITIES

Traffic Volume (ADT)	0-4,000	4-6,000	6-10,000	10-15,000	15-20,000	20,000+
Speed (MPH)	0-24	25-29	30-34	35-39	40-44	45+
Bicycle Boulevard	*Design to achieve 85th percentile speed of 20 mph or less*					
Shared Roadway			*Acceptable*			
			Acceptable	*Provisional**		
Striped Bike Lane				*Acceptable*		
				Acceptable	*Provisional**	
Buffered Bike Lane					*Acceptable*	
					Acceptable	*Provisional**
Separated Bike Lane				*Acceptable*		
Sidepath			*Acceptable*			

**Provisional speed ranges are allowed for the selection of facilities providing improvements associated with the installation of bike facilities are expected to bring traffic speeds within the acceptable range.*

3.5 INTERSECTION TREATMENT SELECTION GUIDANCE

As a result of the best practice research conducted for this task, a recommended typical intersection treatment selection matrix was developed for the City of Hartford. Table 11 summarizes the intersection treatment selection guidance for the City of Hartford.

While the table below provides guidance on typical intersection treatments, the selection of intersection facilities may be unique to an intersection given variables such as geometry, sight-lines, grades, traffic control, signalization, and through and turning traffic volumes.

TABLE 11: TYPICAL INTERSECTION TREATMENT SELECTION MATRIX

Facility Type	Combined Lanes	Bike Pockets	Bike Boxes	Two-Stage Left Turn Boxes	Protected Intersections	Median Refuge Islands	Inter-section Crossing markings
Bicycle Boulevard					*May be provided if intersecting facility has a buffered bike lane, separated bike lane, or sidepath*		
Shared Roadway							
Striped Bike Lane	*Acceptable*						
Buffered Bike Lane							
Separated Bike Lane				*May be provided at signalized intersections*			
Sidepath							

Note: Intersection treatments identified for the bicycle facilities in this table are specific to the bicycle facility on that approach of the intersection. Intersecting bicycle facilities may require unique intersection treatments for those approaches -or- a common intersection treatment may be required for all approaches.

3.6 SOURCES

AASHTO, Guide for the Development of Bicycle Facilities, 4th Edition, American Association of State Highway and Transportation Officials (Washington DC; 888-227-4860; www.aashto.org), 2012

Alta. Lessons Learned: Evolution of the Protected Intersection. (2015). https://altaplanning.com/wp-content/uploads/Evolution-of-the-Protected-Intersection_ALTA-2015.pdf

California Department of Transportation. California Manual on Uniform Traffic Control Devices. (2014). http://www.dot.ca.gov/trafficops/camutcd/

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City of Redmond. Bicycle Facility Design Manual Guidelines. https://nacto.org/wp-content/uploads/2012/07/Redmond-BikeFacilitiesDesignManual.pdf

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Transport for London. London Cycling Design Standards. (2014). https://tfl.gov.uk/corporate/publications-and-reports/streets-toolkit#on-this-page-2

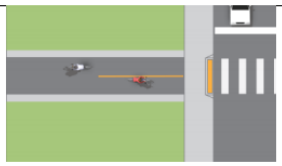
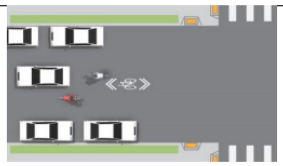
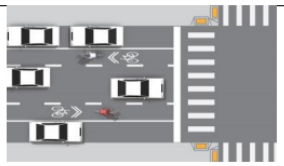
Washington Department of Transportation. Roadway Bicycle Facilities Design Manual. (2015). http://www.wsdot.wa.gov/publications/manuals/fulltext/M22-01/1520.pdf

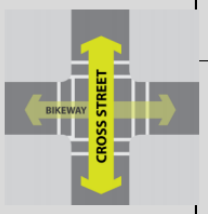
TABLE 12: LIST OF SOURCES FROM UNC CHAPEL HILL STUDY ON BICYCLE FACILITY SELECTION

SOURCE	GUIDELINE	YEAR	URL
Austroads (Australia)	Guide to Traffic Engineering Practice, Part 14 – Bicycles	1999	www.austroads.com.au
Danish Road Directorate	Collection of Cycle Concepts	2000	www.vd.dk
Forschungsgesellschft für Strassenund Verkehrswesen (FGSV, Germany)	Empfehlungen für Radverkehrsanlagen	1995	www.fgsv-verlag.de
CROW (Netherlands)	Sign up for the Bike: Design Manual for a Cycle-Friendly Infrastructure	1993	https://trid.trb.org/view.aspx?id=385473
Institution of Highways and Transportation (United Kingdom)	Guidelines for Cycle Audit and Cycle Review	1998	www.iht.org
Western Australian Planning Commission	Liveable Neighbourhoods, Edition 2	2000	www.planning.wa.gov.au
Federal Highway Administration (USA)	Selecting Roadway Design Treatments to Accommodate Bicycles	1994	www.bikewalk.org/library.htm
Minnesota DOT	Bicycle Transportation Planning and Design Guidelines	1996	www.dot.state.mn.us/sti/biking.html
New Jersey DOT	Roadway Design Manual, Chapter 16 – Bicycle Facilities (draft)	2002	www.state.nj.us/transportation
Oregon DOT	Bicycle and Pedestrian Plan, Section II 1 B: Design Standards		www.odot.state.or.us/techserv/bikewalk/plantext/onrdbkwy.htm
Wisconsin DOT	personal correspondence		
Cambridge MA	personal correspondence		
Davis CA	personal correspondence		
Hamilton ON	Design Guidelines for Bikeways	1999	
Portland OR	Bicycle Master Plan	1996	www.trans.ci.portland.or.us/Plans/BicyceMasterPlan/recomend.htm
Center for Livable Communities (California)	Street Design Guidelines for Healthy Neighborhoods	1999	www.lgc.org/bookstore/land_use/publications/healthystreets.html
University of North Carolina Highway Safety Research Center	Bicycle Compatibility Index	1998	www.hsrc.unc.edu/research/pedbike/bci/

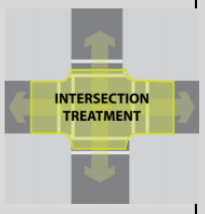
Source: King, Michael. "Bicycle facility selection: A comparison of approaches." (2002).

3.7 SEATTLE BICYCLE FACILITY INTERSECTION TREATMENT SELECTION

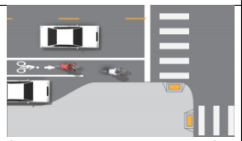
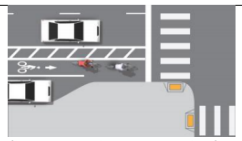
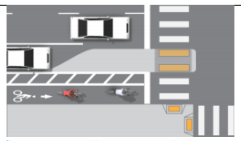
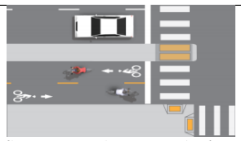
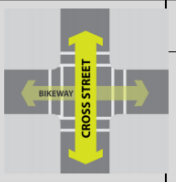
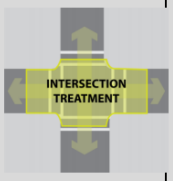
Roadway Type:	Off-Street Alignment	Non-arterial	
Auto Volumes:	N/A	< 1,500 ADT	~3,000 ADT
Bicycle Facility Types	 **Multi-use Trail****	 **Neighborhood Greenway**	 **Neighborhood Greenway Advisory Bike Lane**



Cross Street Type:	Non-arterial Crossings	Arterial Crossings	Non-arterial Crossings	Arterial Crossings	Trail Crossings
Cross-Street Approach	• Advance Trail Crossing Sign • Trail Sign	• Advance Trail Crossing Sign • Trail Sign	• Stop Signs with Stop Bars • Neighborhood Greenway Sign	• Advance warning signs • Neighborhood greenway sign	• Advance Warning Sign • Advance Warning Marking • Stop Sign • Raised Intersection
Intersection Treatment	• Advance Warning Sign • Advance Warning Marking • Stop Sign • Raised Intersection	• Raised intersection • Active Warning Beacons • Bicycle Signal[2] • Full Signal • Overhead Crossing sign (passive) • Advance Warning Sign • Advance warning Marking • Stop Sign	• Intersection Diverter • Traffic Circle • Pavement marking • No parking signs (at discretion of engineer)	• Curb • Raised Intersection • Active Warning Beacons • Pedestrian Hybrid Beacon • Half Signal • Bicycle Signal[2] • Full Signal • Bike Box2 • Signal Detection[2] • Bicycle Forward Stop Bar • Offset Street Connection • Widen Sidewalk • Partial Closure • Median Diverter Island • Through Bike Lanes • Intersection Crossing Markings	• Advance Trail Crossing Signs • Marked Crosswalk • Raised Intersection • Trail Signs • Stop Sign



SOURCE: 2014 SEATTLE BICYCLE MASTER PLAN

	**Roadway Type:**	**Collector Arterial**			**Minor Arterial**		**Principal Arterial**
	Auto Volumes:	< 8,000 ADT		<15,000 ADT	>15,000 ADT		>15,000 ADT
	Bicycle Facility Types	 (in street, minor separation) **Advisory Bike Lane**[1] **Conventional Bike Lane**		 (in street, minor separation) **Conventional Bike Lane Buffered Bike Lane**	 (in street, minor or major separation) **Buffered Bike Lane Cycle track**		 (in street, major separation) **Cycle Track**
	**Cross Street Type:**	**Non-arterial Crossings**	**Arterial Crossings**	**Trail Crossings**	**Non-arterial Crossings**	**Arterial Crossings**	**Trail Crossings**
	Cross-Street Approach	• Two-Stage Turn Box	• Two-Stage Turn Box	• Advance Warning Sign • Advance Warning Marking • Stop Sign	• Two-Stage Turn Box	• Two-Stage Turn Box	• Advance Warning Sign • Advance Warning Marking • Stop Sign
	**Intersection Treatment**	• Intersection Crossing Markings	• Intersection Crossing Markings • Median Refuge Island • Active Warning Beacons • Half Signal • Bicycle Signal[2] • Full Signal • Bike Box[2] • Combined Bike Lane/Turn Lane • Two-Stage Turn Box • Through Bike Lanes • Signal Detection[2] • Forward Stop Bar • Offset Street Connection	• Advance trail crossing signs • Jogged Street Multi-use Trail or Widened Sidewalk • Marked Crosswalk • Raised intersection • Active Warning Beacons • Bicycle Signal[2] • Half Signal • Full Signal • Overhead Crossing sign (passive)	• Maintain Raised Cycle Track • Intersection Crossing Markings • Two-Stage Turn Box	• Intersection Crossing Markings • Median Diverter Island • Active Warning Beacons • Hybrid Beacon • Bicycle Signal[2] • Full Signal • Green Bike Box[2] • Combined Bike Lane/Turn Lane • Two-Stage Turn Box • Through Bike Lanes • Signal Detection[2] • Forward Stop Bar • Offset Street Connection	• Advance trail crossing signs • Jogged street multi-use trail or widened sidewalk • Marked Crosswalk • Active Warning Beacons • Bicycle Signal[2] • Half Signal • Full Signal • Overhead Crossing sign (passive)

SOURCE: 2014 SEATTLE BICYCLE MASTER PLAN (CONT.)

4 DESIGN GUIDANCE

This section provides the City of Hartford with a framework for the design of bicycle facilities throughout the city. The content focuses primarily on the provision of best practice design solutions to create complete streets that are safe and enjoyable for all bicyclists regardless of age or ability. It provides a set of recommended bicycle facility design guidelines that are tailored to fit Hartford's unique street network and neighborhood environment.

4.1 NATIONAL STANDARDS AND LOCAL PLANNING

This manual is intended to supplement existing national standards and guidelines for bicycle facility design, and provide the City of Hartford with a framework for the planning, design, and implementation of a safe and effective network of bicycle facilities. The design guidelines created for this manual were based on national standards as well as other bicycle facility design manuals from local jurisdictions across the country, which were tailored to meet the unique characteristics of Hartford. The following national standards and local planning guides were used to formulate the Hartford Bicycle Facility Design Manual (see Figure 4-1).

NATIONAL STANDARDS

Figure 4-1: National standards resources

- American Association of State Highway and Transportation Officials (AASHTO) 2012 Guide for the Development of Bicycle Facilities
- The Federal Highway Administration's (FHWA) Manual on Uniform Traffic Control Devices (MUTCD 2009)
- FHWA 2015 Separated Bike Lane and Planning Design Guide
- The National Association of City Transportation Officials' (NACTO) 2012 Urban Bikeway Design Guide

LOCAL LEVEL BICYCLE PLANS AND DESIGN GUIDELINES

- California Department of Transportation (Caltrans) Highway Design Manual
  http://www.dot.ca.gov/design/manuals/hdm.html
- City of Davidson, North Carolina Active Transportation Plan
  http://www.ci.davidson.nc.us/DocumentCenter/View/4305
- City of Redmond, California Bicycle Facilities Design Manual Guidelines
  https://nacto.org/wp-content/uploads/2012/07/Redmond-BikeFacilitiesDesignManual.pdf
- Denver Bikeway Design Guidelines
  https://www.denvergov.org/content/dam/denvergov/Portals/708/documents/plans-studies/denver-bikeway-design-guidelines-draft.pdf

- Massachusetts Separated Bike Lane Planning & Design Guide 2015
- Minnesota Department of Transportation (MNDOT) 2007 Bikeway Facility Design Manual http://www.dot.state.mn.us/bike/design-engineering.html
- Ontario Traffic Manual Book 18 Cycling Facilities http://www.raqsb.mto.gov.on.ca/techpubs/eps.nsf/0/825810eb3ddd203385257d4a0063d934/$FILE/Ontario%20Traffic%20Manual%20-%20Book%2018.pdf
- Seattle Bicycle Master Plan https://www.seattle.gov/transportation/bikemaster_materials.htm
- Washington Department of Transportation (WDOT) Roadway Bicycle Facilities Design Manual http://www.wsdot.wa.gov/publications/manuals/fulltext/M22-01/1520.pdf

Detailed best practice summaries for the selection and design of bicycle facilities from each of these resources can be found in the Section 3 of this Plan.

4.2 BICYCLE FACILITY DESIGN

The following sections provide brief descriptions and design guidelines for a variety of bicycle facilities that would complement Hartford's existing street network. Although this section provides guidance on bicycle facility design, it is important to remember that urban streets are extremely complex and any roadway treatment must be carefully evaluated and tailored to each specific situation. Sound engineering judgement and in-depth knowledge of bicycle transportation should always be applied to any bicycle facility design.

4.2.1 BICYCLE BOULEVARD

DESCRIPTION

Bicycle boulevards are low speed and low volume streets that have been designed to optimize bicycle travel. They typically incorporate various traffic calming treatments that prioritize the safe and efficient movement of bicyclists and may discourage through motor vehicle traffic. A key benefit of bicycle boulevards is the ability of these facilities to offer relatively low-cost solutions in redesigning streets that are safe and attractive for bicyclists of all ages. Some streets already have the needed low volumes and speeds and will just require signage and wayfinding to make them part of the City's bike network. Others will require traffic calming and the main challenge with their implementation will be working with the neighborhood and adjacent property owners to develop acceptable means of slowing and or diverting traffic. Another challenge will be to effectively link bicycle boulevards into a larger bicycle network. Many of the quiet side streets in Hartford are discontinuous, with discontinuities caused by topography, rivers/streams, and transportation facilities (interstates, railroads).

Bicycle boulevards can provide alternative bicycle routes for cyclists who are reluctant to travel on high volume/higher speed corridors where dedicated bicycle facilities may or may not be present. Bicycle boulevards are ideally located on local streets that are parallel to arterial corridors, thus acting as an alternative to the primary corridor for bicycle travel. Bicycle boulevards should be considered in proximity to arterial corridors where there is strong demand for bicycle access yet the roadway conditions on those corridors are not favorable to bicyclists and modification of the road will require long term, high capital cost, projects.

Bicycle boulevards are recommended for use on local streets with an average daily traffic of less than 4,000 vehicles per day, or must be provided with traffic diversion measures intended to reduce the traffic volume to this threshold. This threshold matches the City's limit for the installation of speed humps on local streets. Since traffic calming tools such as speed humps are integral to the design of bicycle boulevards, a common traffic volume threshold is recommended. In addition to the City's speed hump program requirements, the Manual for Uniform Traffic Control Devices provides guidance that recommends the use of yellow centerline pavement stripes on roadways

with an average daily traffic volume of 4,000 vehicles per day or greater. The use of a yellow centerline stripe is not recommended for use on bike boulevards as the channelizing effect works counter to the concept of a shared space where bicycle traffic is prioritized.

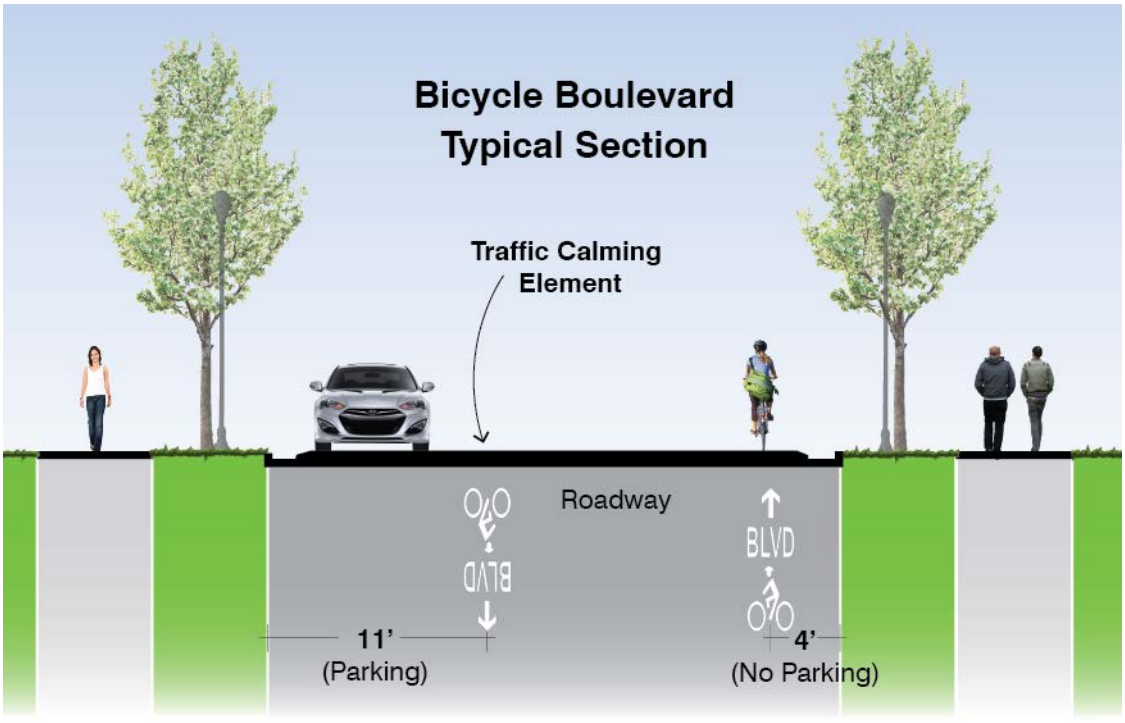


Figure 4-2: Bicycle boulevard typical section

APPLICATION GUIDANCE

- STREET TYPE: Local streets only
- TRAFFIC VOLUME: Less than 4,000 ADT
- 85TH PERCENTILE SPEEDS: Design to achieve 85th percentile speed of 20 mph or less

DESIGN GUIDANCE

GEOMETRY

- Bike Boulevards comprise the entire roadway from curb to curb

PAVEMENT MARKINGS

- Bicycle Boulevard pavement markings or sharrows, should be incorporated.
  - Pavement markings should be at least 3' wide.
  - Pavement markings should be placed immediately after an intersection and spaced at intervals no greater than 250 feet.

Figure 4-1: Bike boulevard pavement marking

- Minimum placement of the pavement marking centerline should be at least 11 feet from the face of the curb where on-street parking is present, and 4 feet from the face of the curb where no on-street parking is present.
- Preformed thermoplastic pavement markings are preferred over the use of painted stencils due to durability of thermoplastic markings.

SIGNAGE

- Bike boulevard signage should be placed along the corridor to inform motorists of the presence of bicyclists and to provide wayfinding for bicyclists. Recommended placement includes:
  - Beginning of a bicycle boulevard.
  - At major changes in direction or intersections with other bicycle routes.

Figure 4-2: Bike boulevard signage

OTHER TREATMENTS

- Traffic diversion may be required to slow traffic speeds or manage traffic volume to achieve an average daily traffic of less than 4,000 vehicles. Diversion treatments can include:
  - Diagonal diverters – physical roadway barriers placed diagonally across an intersection, blocking through movement and requiring all vehicles to turn. The diverter would permit bicycle traffic.
  - Partial closures – physical roadway barriers that block through movement traffic in one direction for a short distance, resulting to one-way traffic on otherwise two-way streets. The closure would permit bicycle traffic.
  - Full closures – physical roadway barriers placed across a street to completely close the street and restrict vehicles from continuing onto the roadway. The closure would permit bicycle traffic.
- Traffic calming treatments should be used to achieve 85th percentile speeds of less than 25 mph. Traffic calming treatments can include:
  - Traffic circles – raised circular islands constructed in the center of residential or local street intersections.
  - Chicanes – a series of raised curb extensions placed on alternative sides of the street to form an S-shaped travel way. They help reduce travel speeds by narrowing the travel lanes and by requiring drivers to shift laterally to navigate through the S-shape design.
  - Pinch-points – curb extensions used to narrow a street enough so that two drivers would have difficulty passing each other simultaneously.
  - Speed humps – a series of raised areas placed on a roadway to slow down motorists.

MAINTENANCE

Since the cycling facility is not a dedicated facility, the maintenance of shared routes is consistent with the maintenance of the roadway itself. However, diverters, chicanes and partial road closures might require modifications to street drainage systems.

LIMITATIONS

Bike boulevards operate on the principle that the bicyclist is prioritized as a user of the roadway, which requires the willing participation of motorists. While bike boulevards are designed to achieve low traffic speeds, bicyclists are not otherwise separated or protected from motor vehicles. Traffic diversion measure may be required to ensure that bike boulevards are serving neighborhood traffic and not cut-thru traffic, the latter of which is more likely to operate at high speeds and be less deferential to bicyclists.

Figure 4-5: Bike boulevard in West Baltimore, MD. Source: www.bikemore.net

4.2.2 SHARED ROADWAY

DESCRIPTION

Shared road facilities allow bicyclists and motor vehicles to use the same roadway space without any separate right-of-way designations. One of the key benefits of shared road facilities is the ability to integrate a bicycle facility on a street that may not have otherwise had sufficient right-of-way to accommodate a striped bicycle lane. One of the key challenges, however, is that they do not provide improved safety for bicyclists, beyond making their presence more visible and expected. Studies have shown that shared lanes with sharrow markings may encourage motor vehicle operators to give bicyclists more room on the road. These facilities are prone to bicycle and vehicular conflicts because of the lack of designated space and/or separation between bicyclists and motorists.

Shared road facilities can be implemented on both wide (13' or greater) and narrow traffic lanes. The width of a traffic lane impacts bicyclists differently, creating different bicycling behaviors. Wide shared traffic lanes allow bicyclists to ride side-by-side with motor vehicles, but are still too narrow for the striping of a separate bike lane. On a wide shared road facility, bicyclists can choose to ride near the curb or they can take the lane and ride in the middle of the roadway. On narrow shared traffic lane (facilities where side by side sharing cannot occur), bicyclists must take the lane and ride in the middle of the roadway.

Shared roadways should be used where the provision of dedicated bicycle lanes or other dedicated bicycle facilities is not feasible due to geometric or right-of-way constraints. Shared

roadways can be a valuable tool in extending and connecting a bike network and providing strategic connections between corridors with dedicated bicycle facilities. Shared roadway pavement markings and signage provide cyclists with wayfinding assistance and promote awareness of the presence of cyclists in the roadway environment.

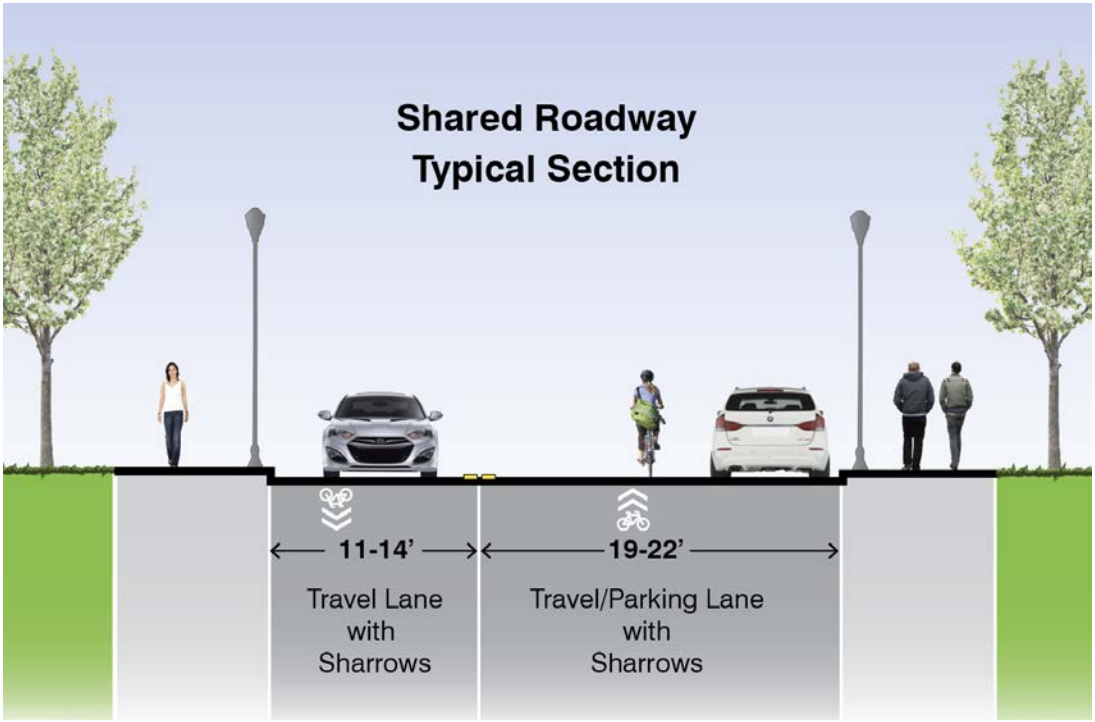


Figure 4-6: Shared roadway typical section

APPLICATION GUIDANCE

- STREET TYPE: Local, collector, and minor arterial
- PREFERRED TRAFFIC VOLUME: Less than 6,000 ADT
  - ACCEPTABLE TRAFFIC VOLUME: Less than 10,000 ADT
- PREFERRED 85TH PERCENTILE SPEEDS: Less than 30 mph
  - ACCEPTABLE 85TH PERCENTILE SPEEDS: Less than 35 mph
  - *PROVISIONAL* 85TH PERCENTILE SPEEDS: Less than 40 mph*
    *(*Requires the planned reduction of traffic speeds to acceptable levels)*

DESIGN GUIDANCE

GEOMETRY

- Shared Traffic Lane Width
  - Shared Roadways with less than 6,000 ADT (and two traffic lanes or less): Roadway may vary significantly in width providing no centerline pavement marking is present.
  - Shared Roadways with less than 8,000 ADT: Shared traffic lane should be a minimum of 11 feet wide.

  - Shared Roadways with 8,000-10,000 ADT: Shared traffic lane should be a minimum of 13 feet wide.
- Shared Parking/Traffic Lane Width (parking lane is not delineated by a stripe)
  - Shared Roadways with less than 8,000 ADT: Shared parking and traffic lane should be a minimum of 19 feet wide.
  - Shared Roadways with 8,000-10,000 ADT: Shared parking and traffic lane should be a minimum of 21 feet wide.

PAVEMENT MARKINGS

- Shared lane markings, or sharrows, should be incorporated.
  - Sharrows should be at least 3 feet wide by 9 feet long.
  - Minimum placement of the sharrow centerline should be at least 11 feet from the face of the curb where on-street parking is present, and 4 feet from the face of the curb where no on-street parking is present.
  - Sharrows should be placed immediately after an intersection and spaced at intervals no greater than 250 feet.
- Centerline markings should not be applied to, and should be removed from, shared roadways with less than 6,000 ADT unless required due to roadway curvature or other unique conditions.

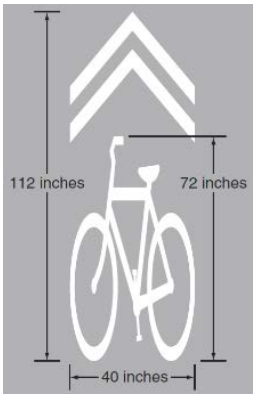


Figure 4-3: Sharrow pavement marking

SIGNAGE

- "Bikes May Use Full Lane" (MUTCD R4-11) signage should be placed along the shared roadway corridor to inform motorists of the presence of bicyclists and their right to occupy the full traffic lane if conditions require. Recommended size is 24".
- A "STATE LAW" header panel should be provided above the R4-11 sign as per MUTCD Section 2A.15.C. to enhance the conspicuity of the sign.
- Recommended placement includes:
  - Beginning of a shared roadway.
  - Following signalized intersections.

Figure 4-4: Shared roadway signage

MAINTENANCE

Since the cycling facility is not a dedicated facility, the maintenance of shared roadways is consistent with the maintenance of the roadway itself.

LIMITATIONS

Similar to bike boulevards, shared roadways require the deference of motorists to bicyclists when operating in the same spaces. The collection and assessment of roadway operating speeds is critical in selecting and designating shared roadways. Traffic calming measures may be required to reduce traffic operating speeds to support the designation of a shared roadway.

Figure 4-9: Example of a shared roadway, Manhattan Beach, CA Source: South Bay Bicycle Coalition

4.2.3 STRIPED BIKE LANE

DESCRIPTION

Striped bike lanes designate an exclusive space on the roadway for bicycle travel, which is signified by pavement markings, striping, and signage. They are typically located on the right side of the street (on a two-way street) between a motor vehicle travel lane and the curb, road edge, or parking lane. Benefits of conventional bike lanes include increasing bicyclists comfort on busy streets, designating a separate and exclusive space for both bicyclists and motorists, and improving awareness of the presence of bicyclists to drivers. Striped bike lanes are not suitable for all users as some bicyclists, especially those with less experience and confidence, do not feel comfortable riding without physical separation from traffic.

Striped bicycle lanes are also used as climbing bike lanes. Climbing bike lanes are striped bicycle lanes that are placed in the uphill direction to provide bicyclists space to ride without slowing down vehicular traffic when approaching an incline. Climbing bike lanes are typically paired with sharrows in the downhill direction when roadway widths are limited.

Striped bicycle lanes are the most abundant bicycle facility type in Hartford currently and will likely remain the most practical accommodation in the short term for bicyclists given fiscal challenges, narrow street rights of way, and competing street uses (particularly parking). Striped bicycle lanes provide separation between bicyclists and traffic and require minimal roadway space which allows for their inclusion via traffic lane width reductions, removal of traffic lanes, and/or removal of on-street parking lanes. Most corridors in Hartford are favorable to this type of facility with respect to traffic volume and speeds.

There are some jurisdictions that allow parking in bike lanes under certain circumstances. For example, in California per the Department of Motor Vehicles (DMV), motor vehicles are allowed to park in a bicycle lane if they do not block a bicyclist and/or there is not a “No Parking” sign

posted.[3] Oregon law also allows for parking in a bicycle lane, however, this is mainly allowed only to pick up and drop off passengers.[4] Parking in bicycle lanes is sometimes allowed by local laws for brief stops to pick-up or drop-off passengers only. To allow more regular parking in a bicycle lane would create obstructions for cyclists, force them into traffic lanes and defeat the purpose of having a bicycle lane, therefore, this is not recommended for Hartford.

APPLICATION GUIDANCE

- STREET TYPE: Local, collector, and minor arterial
- PREFERRED TRAFFIC VOLUME: 4,000 to 10,000 ADT
  - ACCEPTABLE TRAFFIC VOLUME: 4,000 to 15,000 ADT
- PREFERRED 85TH PERCENTILE SPEEDS: Less than 35 mph
  - ACCEPTABLE 85TH PERCENTILE SPEEDS: Less than 40 mph
  - *PROVISIONAL* 85TH PERCENTILE SPEEDS: Less than 45 mph*
    *(*Requires the planned reduction of traffic speeds to acceptable levels)*

DESIGN GUIDANCE

GEOMETRY

- Striped bike lanes should be 5 feet wide on roadways with less than 10,000 ADT and 6 feet wide on roadways with 10,000 ADT or more.
- When placed between a parking lane and traffic lane, the parking lane should be a minimum width of 8’ when paired with a 5’ wide bicycle lane and may be a minimum width of 7’ when paired with a 6’ foot wide bike lane so that the combined width of the parking lane and bicycle lane is no less than 13 feet.

PAVEMENT MARKINGS

- A solid white lane marking (typically 6 inches in width) should be used to separate the bike lane from the motor vehicle travel lane.
- Pavement markings should include bicycle lane symbols to define the bike lane.
- Bike lane symbol pavement markings should be 3’ wide.
- Bike lane symbol pavement markings should be placed immediately after an intersection and spaced at intervals no greater than 500 feet.
- Preformed thermoplastic pavement markings are preferred over the use of painted stencils due to durability of thermoplastic markings.
- Green pavement color may be used to help enhance the visibility of a striped bike lane in locations with high traffic volumes, large numbers of turning movements, or where bike lanes cross traffic lanes. Note that colored pavement has a high maintenance cost.

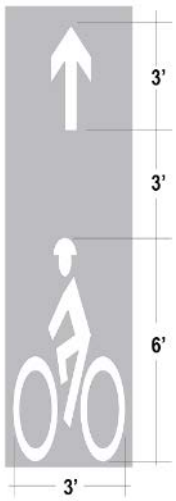


Figure 4-5: Bike lane symbol pavement marking

[3] California Department of Motor Vehicles. “California Driver Handbook – Lane Control” https://www.dmv.ca.gov/portal/dmv/detail/pubs/hdbk/traffic_lanes.
[4] Oregon Revised Statutes. https://www.oregonlaws.org/ors/811.560

SIGNAGE

- Bicycle lane signage (MUTCD R3-17) is not required but may be used at the beginning of a bicycle lane or immediately following a signalized intersection.
- "Bike Lane Ahead" and "Bike Lane Ends" signage is not necessary
- Recommended sign size is 24"x18".

Figure 4-6: Bike lane signage

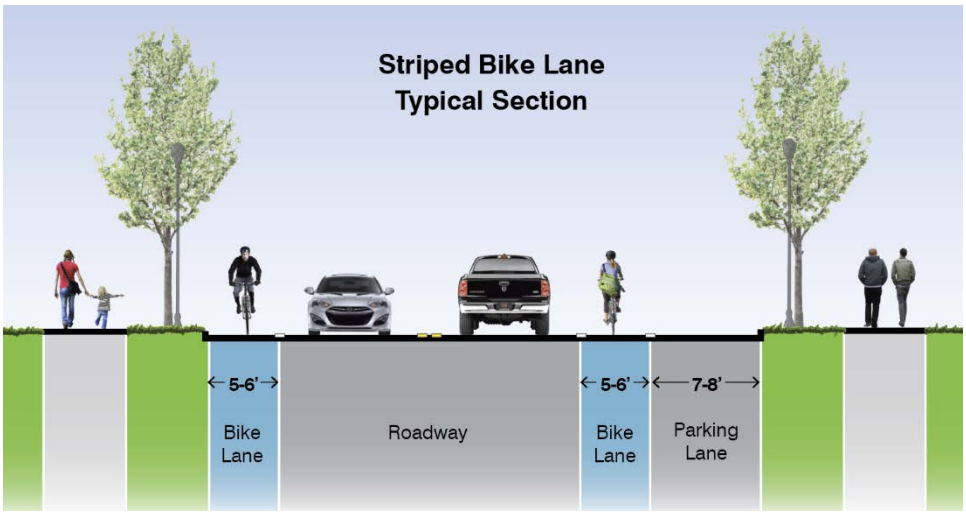


Figure 4-12: Striped bike lane typical section

Figure 4-13: Striped bicycle lane, Locus Street, Hartford

MAINTENANCE

Striped bike lanes can be maintained using the conventional processes for roadway maintenance, including winter maintenance. Where bike lanes are introduced on a roadway, consideration should be given to increasing sweeping in the fall and spring, as dirt and grit and broken glass impacts cyclists more significantly than motorists, and tends to accumulate along the edges of the roadway.

LIMITATIONS

Striped bike lanes are a versatile, high value facility. While striped bike lanes provide separation between traffic and bicyclists, proper intersection treatments are required to avoid conflicts with right-turning vehicles and to assist in bicyclist left-turn movements.

4.2.4 BUFFERED BIKE LANE

DESCRIPTION

Buffered bicycle lanes are striped bike lanes with a painted, colored, or textured at grade buffer space that is used to separate the bike lane from the adjacent motor vehicle lane and/or parking lane. This type of facility provides an improved level of comfort for the bicyclist above that provided by a simple bicycle lane by providing more space between bicyclists and motorists and more space for bicyclists to pass one another without encroaching onto the travel lane.

The buffers typically include pavement striping and markings to alert drivers and to create a space between them and bicyclists. A shallow rumble strip can also be used. Buffered bike lanes can potentially be converted into separated bike lanes at a future time. One of the challenges of incorporating buffered bicycle lanes is the additional right-of-way needed to accommodate the buffer space. Additionally, because buffers typically take the form of striping or other pavement markings, they lack the physical separation between bicyclists and motorists that the less confident and less experienced bicyclist desires. Buffered bike lanes may also require additional maintenance when compared to a conventional bicycle lane because of the need to maintain the buffer striping or pavement.

A large benefit of buffered bike lanes compared to separated bike lanes is that they cost less to construct and do not require specialized equipment for winter maintenance or spring time sweeping. Although buffered bike lanes help improve safety for bicyclists, they still require additional treatments to improve safety at intersections. Without additional intersection treatments, bicyclists will still experience conflicts with motor vehicles.

Buffered bicycle lanes should be used where traffic volume and/or speed requires additional separation between bicyclists and traffic so as to improve bicyclist safety and comfort. Given the space required for the bicycle lane and buffer, there are likely few corridors in Hartford that are currently suitable candidates for buffered bicycle lanes without the elimination of parking lanes, traffic lanes, or significant reconstruction of the roadway.

APPLICATION GUIDANCE

- STREET TYPE: Collector, minor arterial, and principal arterial
- PREFERRED TRAFFIC VOLUME: 10,000 to 15,000 ADT
    - ACCEPTABLE TRAFFIC VOLUME: 10,000 to 20,000 ADT
- PREFERRED 85TH PERCENTILE SPEEDS: Less than 40 mph
    - ACCEPTABLE 85TH PERCENTILE SPEEDS: Less than 45 mph
    - *PROVISIONAL* 85TH PERCENTILE SPEEDS: 45+ mph*
      *(*Requires the planned reduction of traffic speeds to acceptable levels)*

DESIGN GUIDANCE

GEOMETRY

- Buffered bike lanes should have the following minimum bike lane widths:
  - Minimum bike lane width of 4 feet if buffered on both sides.
  - Minimum bike lane width of 5 feet if buffered on one side.
- Buffer should be a minimum of 2 feet wide, but 3 feet is preferable. Buffers wider than 3 feet are not beneficial in urban applications.
- Bike lanes should include parking lane side buffers when located adjacent to parking lanes in areas of high parking turnover such as metered spaces, time-limited spaces, and retail areas.
- The combined width of the parking lane and the adjacent buffer shall be no less than 9 feet; 10' is preferred.

PAVEMENT MARKINGS

- A solid white lane marking (typically 6 inches in width) should be used to separate the bike lane from the motor vehicle travel lane.
- Pavement markings should include bicycle lane symbols to define the bike lane.
- The buffer area should be marked with two solid white lines with interior diagonal cross hatching, chevron markings, or colored or textured pavement.
- If a shallow rumble strip is used it should also be 6 inches in width and be located along the edge of the traffic lane to warn motorists that they are encroaching into the buffered area.
- Green pavement color may be used to help enhance the visibility of a striped bike lane in locations with high traffic volumes, large numbers of turning movements, or where bike lanes cross traffic lanes. Note that colored pavement has a high maintenance cost.

SIGNAGE

- Bicycle lane signage (MUTCD R3-17) is not required but may be used at the beginning of a bicycle lane or immediately following major intersections.
- "Bike Lane Ahead" and "Bike Lane Ends" signage is not necessary
- Recommended sign size is 24"x18".

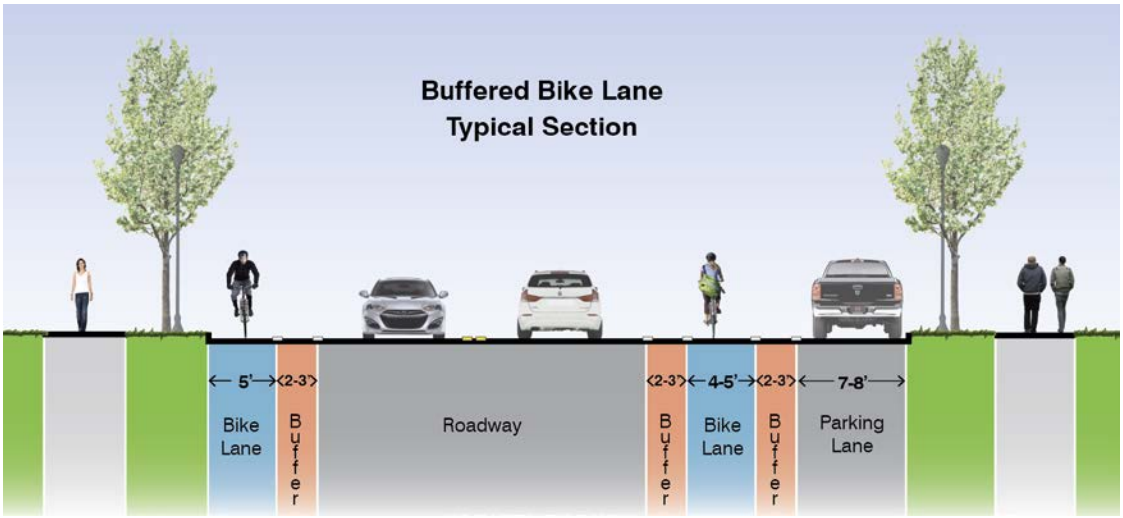


Figure 4-14: Buffered bike lane typical section

Figure 4-15: Buffered bicycle lane, Seattle, WA

MAINTENANCE

Similar to bike lanes, buffered bike lanes can be maintained using conventional practices for roadway maintenance. In some cases, where heavy snowfall is anticipated, a second pass of the buffered bike lane can help to clear facilities. The buffer width can be used for additional snow storage as needed. Where bike lanes are introduced on a roadway, consideration should be given to increasing sweeping in the fall and spring, as dirt and grit and broken glass impacts cyclists more significantly than motorists, and tends to accumulate along the edges of the roadway. It should be noted that with a buffered bike lane, passing traffic has less of an impact in blowing debris to the edge /curb and debris may accumulate more in this type of facility than a striped bicycle lane without a buffer. The addition of a shallow rumble strip does not affect maintenance costs.

LIMITATIONS

Like striped bike lanes, buffered bike lanes provide separation between traffic and bicyclists. Proper intersection treatments are also required to avoid conflicts with right-turning vehicles and to assist in bicyclist left-turn movements. Buffered bike lanes may be more difficult to accommodate within Hartford's transportation network due to additional roadway space required for the buffers. Additionally, the separation provided by the buffer may result in marginally higher traffic speeds as drivers perceive additional operating space and additional separation from bicyclists.

4.2.5 SEPARATED BIKE LANE

DESCRIPTION

Separated bike lanes are physically separated from motor vehicle traffic Physical separation for separated bike lanes can include on-street parking, bollards, delineators, planters, raised medians, or raised facilities. They can be designed for one-way or two-way travel and can be at street level, at sidewalk level, or at an intermediate level between the two. Mass DOT has a very comprehensive guide to Separated Bicycle Lanes. The Mass DOT guide has far more detail that we are able to provide in this document and will be a useful reference when Hartford installs a separated bike lane.

Separated bike lanes are friendly to novice riders and riders of all ages because of the physical separation from traffic which is provided by a curb, landscaping, and/or other measures. While separated bike lanes improve safety and comfort along a corridor, the physical separation can lead to additional conflicts with turning motor vehicles at intersections and even at driveways. Therefore they require special treatment at intersections to maintain safety. Separated bike lanes usually require a dedicated traffic signal system at signalized intersections, or require bicyclists to use pedestrian signals to assist in roadway crossings. Additionally, a separated bike lane, with its physical separation, poses challenges for maintenance. Specialized equipment that could fit into the separated bike lane would be needed for snow clearing and regular sweeping.

Two-way separated bike lanes located on one side of the roadway may be a desirable facility where the opposing side of the roadway experiences significant turning movements such as at a highway interchange. They are also desirable where the side with the separated bike lane is not interrupted by driveways or intersections, for example, along a park or a river. An advantage of a two-way separated bike lane is that it may require less combined roadway width than one-way separated bike lanes, given that a barrier will be required on only one side of the road. A two-way separated bike lane is currently being designed for Sigourney Street, with the separated bike lane being located on the west side of the roadway, opposite I-84 ramps. Two-way separated bike lanes, even more so than one-way separated bike lanes, create potential conflicts with turning vehicles at driveways and intersections. Turning vehicles do not expect fast moving traffic, flowing against the normal traffic direction, on the right side of the roadway.

Some of the key challenges, then, of implementing separated bike lanes include high implementation costs, lack of sufficient right-of-way, the need for intersection treatments, and maintenance challenges.

APPLICATION GUIDANCE

- STREET TYPE: Minor and principal arterials
- PREFERRED TRAFFIC VOLUME: 15,000 ADT or more
    - ACCEPTABLE TRAFFIC VOLUME: 10,000 ADT or more
- PREFERRED 85TH PERCENTILE SPEEDS: 25 mph or more

DESIGN GUIDANCE

GEOMETRY

- One-Way Separated Bike Lanes (Figure 4-16):
  - Minimum width of 5 feet.
  - Preferred width of 6 feet.
  - Width may be increased up to a maximum of 10 feet on high demand/high volume corridors (greater than 150 cyclists per hour).
- Two-Way Separated Bike Lanes (Figure 4-17):
  - Minimum width of 8 feet.
  - Preferred width of 10 feet.
  - Width should be increased up to a maximum of 14 feet on high demand/high volume corridors (greater than 150 cyclists per hour).
- Buffer Width (off-street separated lanes): For a lane at sidewalk height: The minimum width of the buffer (offset from the curb face) should be 2 feet. The provision of this space keeps cyclists safely away from the curb where there is risk of accidentally riding into the roadway. A 2-foot buffer space also provides the minimum space needed to accommodate utility structures such as utility poles, light poles, traffic sign posts and fire hydrants. The preferred minimum width is 3 feet, which provides additional separation from traffic and additional space for traffic signs that require more than one post. The buffer also provides space for the provision of driveway aprons. If the buffer space is less than 3 feet, the separated bike lane would be required to reduce grade at driveways to meet the driveway grade as it transitions from the roadway grade. A minimum buffer width of 3 feet is also required for areas where on-street parking serves as the physical separation for the bike lane so as to reduce door zone conflicts.
- Buffer Width (on-street separated lanes): The on-street buffer between a parking lane that is used to physically separate a bike lane from the travel way should be a minimum of 3 feet so as to reduce door zone conflicts. Where means other than parked cars are used to separate a bike lane from travel lanes, the minimum buffer distance is 2 feet, but 6 feet is preferred.

PAVEMENT MARKINGS

- A single yellow 4” wide centerline should be applied to two-way facilities. The line may be solid or dashed.
- When placed directly adjacent to a sidewalk of the same pavement material, a 4” wide white stripe should be applied at the edge of the bike lane, adjacent to the sidewalk.
- Bike lane symbol pavement markings should be placed immediately after an intersection and spaced at intervals no greater than 500 feet.
- Bike lane symbol pavement markings should be 3’ wide and placed in the center of each bike lane.

SIGNAGE

- Bicycle lane signage is not required.

OTHER TREATMENTS

- Physical buffer treatments can include traffic delineator posts, planters, landscaping, on-street parking, raised medians, or curbs.
- Separated bike lanes can be at grade with the roadway or raised. Although some jurisdictions place separated bike lanes at an intermediate height between street and sidewalk level, this is not recommended for the City of Hartford because of the level of maintenance this would require especially during the winter season.
- Two-way separated bike lanes should include full signalization at all major intersections including bicycle signals oriented toward the separated bike lane and controlled left or right turn signals, as appropriate, for general traffic. Separated bicycle lanes may instead use a pedestrian signal phase at intersections when paired with a protected intersection that has signal actuators that are accessible by bicyclists.
- Unsignalized intersections should include full signage to warn both motorists and bicyclists of the conflict point.
- Separated bike lane pavement color or pavement materials should be distinct from sidewalk color or materials when separated bike lanes are placed directly adjacent to, and at grade with, a sidewalk.

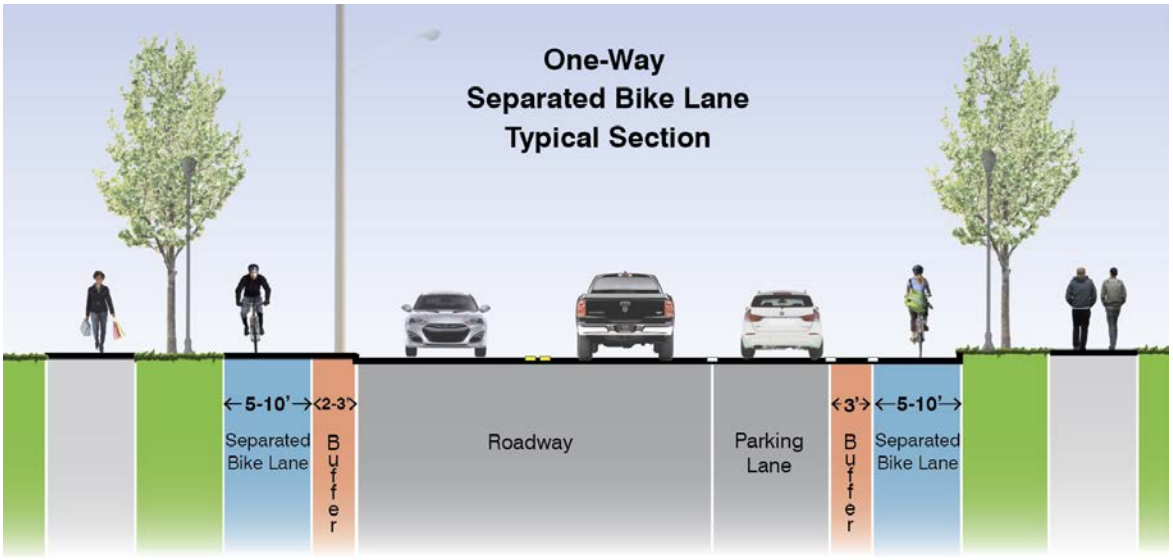


Figure 4-16: One-way separated bike lane typical section

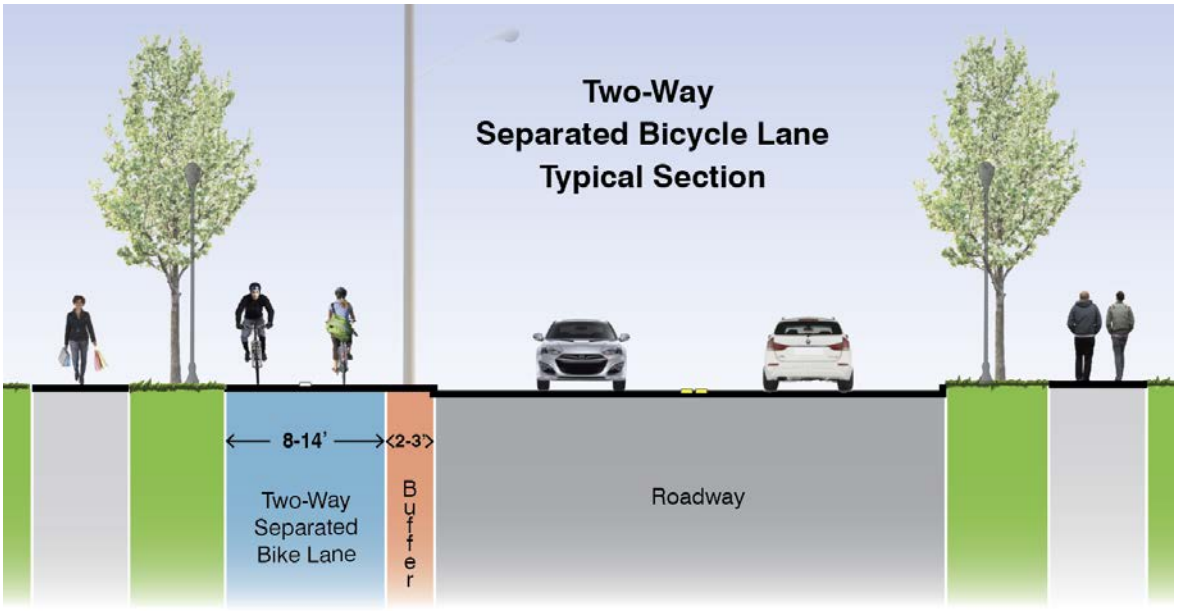


Figure 4-17: Two-way separated bike lane typical section

MAINTENANCE

Where the sidewalk and separated bike lanes are provided at the same elevation in the boulevard, they can be maintained using the same equipment. During the winter, a pick-up truck or mid-sized tractor equipped with a plow or sweeper and de-icing equipment can be used to clear snow from both the sidewalk and the separated bike lane into the edge zone (boulevard). Although sidewalks are cleared of snow by the adjacent property owner, the City would be responsible for clearing snow on the separated bike lanes.

Where the separated bike lane is located at the roadway level and separated through the use of bollards or other similar delineators, a pick-up truck can be used to clear snow from two-way separated bike lanes. For one-way separated bike lanes, a minimum clear width of 5 feet should be maintained in order to allow sidewalk equipment (narrow-gauge tractors or caterpillars equipped with a plow or sweeper and deicing equipment) to be used to clear the separated bike lane. Where the separated bike lane is narrow, this may mean removing the bollards or dividers seasonally. General procedure would be for the roadway to be cleared first, with snow being cleared into the buffer zone between the roadway and cycling facility. The second pass of snow clearing would be the cycling facility, with snow cleared into the same buffer area, so that excess snow accumulates on the roadway (where it will be dissipated by motor vehicles), rather than in the separated bike lane. However, it should be noted that this could potentially result in the snow melting across the separated bike lane and then refreezing. See Figure 4-18.

As a minimum, snow clearing should aim to provide a clear width of 4 feet (for one-way facilities), 8 feet (for two-way facilities). In any case, maintenance of separated bike lanes will require specialized equipment and processes that the City does not use currently.

Figure 4-18: On-road separated bike lane maintained year-round in Hamilton, Ontario. Source: IBI Group

The use of vertical separators with reflective material helps to reduce the likelihood of snow plows damaging the bike lane separators. As shown in Figure 4-19, the bollards are visible even during heavy snowfall.

Figure 4-19: Visibility of bollards in heavy snow conditions. Source: IBI Group

Sweeping of on-road separated bike lanes is especially important, since grit and sand often gets trapped inside the bike lane. For on-road facilities, it may be necessary to sweep twice monthly during the spring (April to May) and fall (September to October), as well as once a month from June-August. For separated bike lanes at sidewalk height, sweeping can be done less frequently (for example, once monthly from April to October). Sweeping of on-road separated bike lanes will require specialized equipment and procedures that are currently not in place or used by the City.

LIMITATIONS

Separated bike lanes, while providing the greatest level of protection and comfort to users along corridors, require special treatments at driveways and intersections to ensure safe operation. This is in part due to the lack of awareness of the presence of bicyclists by motorists who may not see or recognize bicyclists due to their separation from the roadway. Along corridors, driveways are potential conflict points as entering and exiting drivers may not be scanning for bicyclists off of the roadway. At intersections, turning drivers may not be aware of cyclists entering the roadway; the avoidance of this conflict typically requires the provision of a separate bicycle signal phase or the use of a shared bicycle and pedestrian signal phase. In addition to potential unexpected conflicts between bicyclists and motorists, separated bike facilities may introduce more conflicts between pedestrians and bicyclists than bike facilities located on the roadway. These conflicts are likely to occur in areas with on-street parking, resulting in crossing of the bike lane to gain access to the sidewalk and at intersections where pedestrians must cross bike lanes to cross the intersection.

Due to the limitations of separated bike lanes, their use within Hartford should be targeted towards corridors with significant traffic volumes and/or speeds and a potential high demand for bicycling.

Figure 4-20: One-way separated bike lane: Western Avenue, Cambridge, MA

Figure 4-21: Two-way separated bike lane, Mercer Street, Seattle, WA

4.2.6 SIDEPATH

DESCRIPTION

Sidepaths, like shared use pathways, provide a separated facility for the exclusive use of bicycles and pedestrians. These types of facilities are physically separated from motor vehicles with open space or barrier and run adjacent to the roadway. They differ from two-way separated bike lanes in that they are used by both bicyclists and pedestrians. Sidepaths often connect recreational pathways and are commonly found along the edge of parks and water features. Sidepaths may also be used to close gaps in a bicycle network created by features such as a highway interchange.

Sidepaths provide significant flexibility in accommodating bicyclists because the facility can be used by both pedestrians and bicyclists in lieu of a sidewalk and on-street bicycle lanes. A sidepath would likely be used along a corridor where a two-way separated bike lane may be desirable, but where physical or right-of-way constraints do not allow for the provision of a sidewalk and separated bike lane. Sidepaths may also seamlessly connect to shared-use pathways within Hartford's parks, an example being the East Coast Greenway route through Bushnell Park.

Sidepaths can create conflicts when they are located alongside a roadway with multiple driveways or frequent intersections. Turning motor vehicles do not expect fast moving traffic and two-way traffic alongside the roadway and might turn right or left in front of a cyclist.

APPLICATION GUIDANCE

- STREET TYPE: Collector, minor and principal arterials
- PREFERRED TRAFFIC VOLUME: 10,000 ADT or more
  - o ACCEPTABLE TRAFFIC VOLUME: 6,000 ADT or more
- PREFERRED 85TH PERCENTILE SPEEDS: 25 mph or more

DESIGN GUIDANCE

GEOMETRY

- Sidepaths should have a minimum width of 10 feet, preferred width is 12 feet.
- Sidepaths can have a minimum width of 8 feet in constrained locations for limited distances.
- The minimum recommended distance between the roadway and a sidepath is 2 feet from curb face or edge of roadway. The preferred separation is a minimum of 6 feet so as to allow sufficient space for street tree planting and snow storage.
- In areas of relatively flat terrain (areas with grades less than 2 percent), a design speed of 18 mph is recommended, which would require a minimum radius of 60 feet on curves. In areas with hilly terrain (areas with grades of 6 percent or greater), a design speed of 30 mph is recommended, which would require a minimum radius of 166 feet on curves.
- Standard white pedestrian continental style crosswalk markings should be used at roadway crossings. The crosswalk should meet or exceed the width of the approaching sidepath.

PAVEMENT MARKINGS

- A single yellow 4" wide centerline may be applied on curves or in high bicycle traffic areas. The line may be solid or dashed.

SIGNAGE

- A 24" W11-15 bike/pedestrian sign may be used at the entrance of sidepaths following an intersection to notify users of the expected shared use of the pathway.

MUTCD W11-15
Bike/Ped Sign

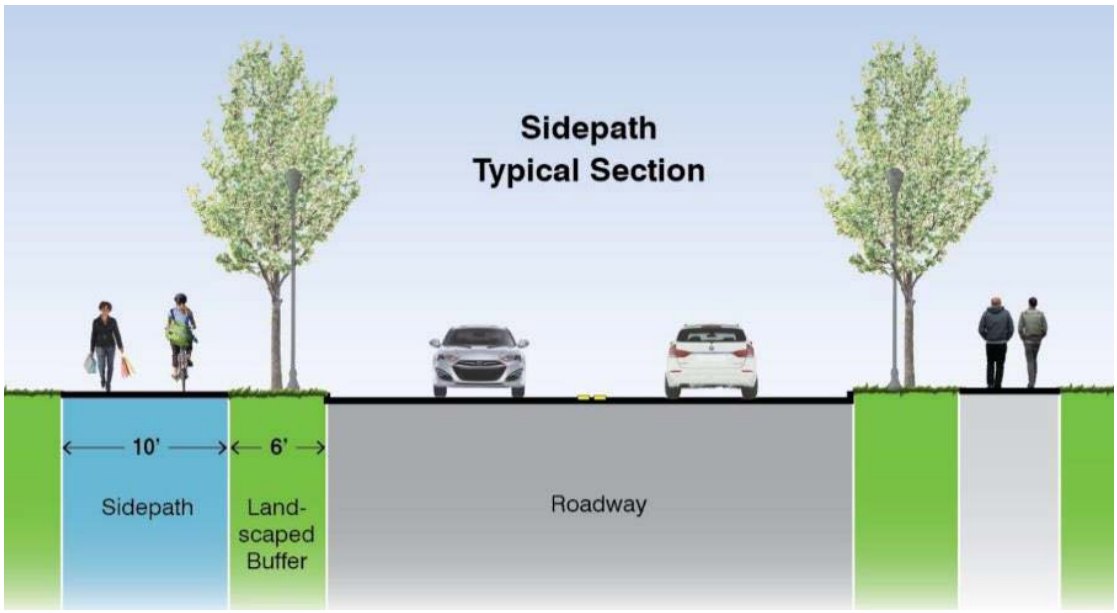


Figure 4-22: Sidepath typical section

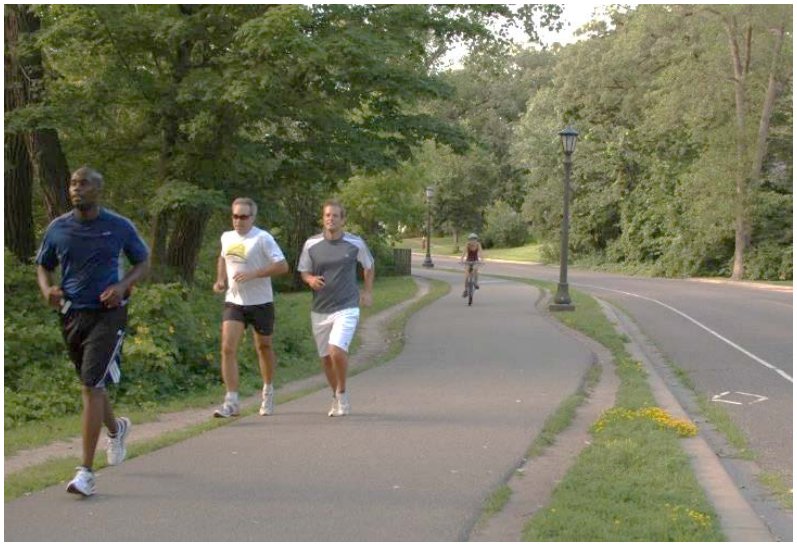


Figure 4-23: Sidepath, Truman Parkway, Boston, MA

MAINTENANCE

Sidepaths can be maintained using a variety of equipment, including equipment typically used for sidewalk maintenance. During the winter, a pick-up truck or mid-sized tractor equipped with a plow or sweeper and de-icing equipment can be used to clear snow into the edge zone (boulevard) located adjacent the pathway. A buffer area of a minimum 5 feet should generally accommodate the average snowfall and depth typical for the Hartford region. During winters of heavy snowfall, the path can be cleared to allow the minimum recommended width (8') since the expected number of users is lower than during warmer months. It should be noted that current practice in the Hartford region is not to clear snow from shared-use paths, however, several pathways in city parks (notably Bushnell Park) are regularly cleared of snow in the winter.

LIMITATIONS

Sidepaths are not ideal facilities for areas of high pedestrian volume and high potential bicycle use due to potential conflicts between the user groups. Like separate bike lanes, sidepaths require proper driveway and intersection treatments in order to reduce conflicts and increase user safety.

4.3 INTERSECTION TREATMENTS

Conflicts between bicyclists and motorists are often heightened at intersection crossings. Somewhat paradoxically, higher level bike facilities, those providing greater separation between bicyclists and motorists, can lead to more conflicts at intersections. This requires improved intersection designs to help to improve safety for bicyclists by enhancing predictability in intersection approaches and crossings for all modes (bike, pedestrian and motor vehicle). Design treatments for intersections should focus on improving the level of visibility, level of awareness, as well as identifying clear rights-of-way between the different modes. The intersection design treatments identified in this manual should be applied only after careful evaluation and should be tailored to fit each specific situation and intersection. Some of the treatments are noted as being necessary with the implementation of particular bicycle facilities.

Proper intersection treatments are critical to providing a well-integrated bicycle network. Intersection treatments vary by approach facility type, intersecting facility type if present, traffic control and roadway characteristics. The treatment identified below provide solutions for most bike facility types. Customized solutions may, however, be necessary for unique circumstances.

4.3.1 COMBINED LANES

DESCRIPTION

Combined lanes are used to reduce bicycle conflicts with right-turning motor vehicle traffic. Combined lanes provide markings that guide a bicyclist through an intersection along the left side of a right-turn lane. This allows through riders to travel with slower moving right-turning traffic. Cyclists making a right turn may ride at the right side of the combined lane. They create a mixing zone between the two modes. Combined lanes are recommended at intersections lacking sufficient space to accommodate a bike pocket.

Combined lanes could be marked at many locations where bicycle lanes terminate prior to an intersection. They can be used as a continuation of a shared roadway, with striped bike lanes, buffered bike lanes, and one-way separated bike lanes. Connecticut statutes allow through bicyclists to position themselves in the far left edge of a right turn lane, whether a sharrow marking is present or not. The addition of a sharrow, however, assists bicyclists in positioning themselves properly and alerts motorist to their potential presence.

Figure 4-24: Combined lane implementation, Billings, MT Source: NACTO 2014 Urban Bikeway Design Guide

APPLICATION GUIDANCE

- Combined lanes may be used with shared roadways, striped bike lanes, and buffered bike lanes.
- Combined lanes are used with a dedicated right turn lane, or if there is a high percentage (50% or more) of right turn movements, with a thru-right traffic lane
- Bike pockets are preferred over combined lanes where space allows.

DESIGN GUIDANCE

- Sharrow pavement markings should be used to indicate bicyclist position within the combined lane. Sharrows should be placed a minimum of 50 feet apart.
- The width of the combined lane should be between 9 to 13 feet.
- A dashed 4" white stripe should be used to mark the transition to the combined lane.
- The transition to the combined lane should begin at a minimum of 50 feet in advance of the intersection, a minimum of 100 feet is preferred.
- A solid 4" white stripe should be provided on the left side of the combined lane extending a minimum of 20 feet from the stop bar.

ADDITIONAL REFERENCES AND GUIDELINES

- AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.
- NACTO. *Urban Bikeway Design Guide*. 2014.

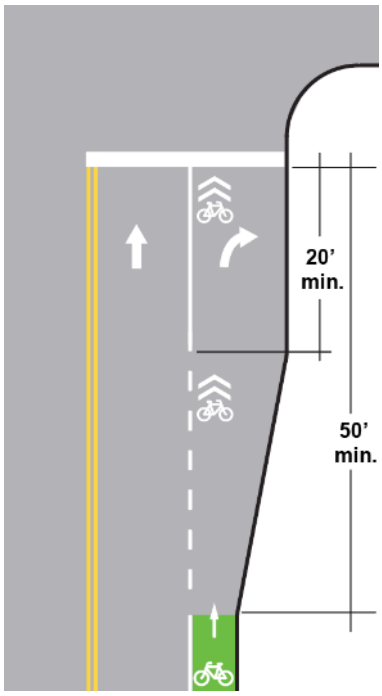


Figure 4-7: Combined lanes

4.3.2 BIKE POCKETS

DESCRIPTION

Bike pockets are design treatments used to reduce bicycle conflicts with right-turning motor vehicle traffic. Bike pockets are placed between right-turn lanes and through travel lanes to clearly distinguish the path for bicyclists traveling straight through the intersection and motor vehicles turning right.

Bike pockets should be incorporated into intersections rather than the common practice of discontinuing bicycle facilities prior to an intersection and resuming bicycle facilities following an intersection. They can be used with striped bike lanes, buffered bike lanes, and one-way separated bike lanes. Bicycle pockets have recently been provided as a feature of bicycle accommodations on Farmington Avenue and Broad Street.

APPLICATION GUIDANCE

- Bike pockets may be used with shared roadways, striped bike lanes, buffered bike lanes, and one-way separated bike lanes.
- Bike pockets are only used between dedicated right turn lanes and thru-traffic lanes.
- Bike pockets may be used at signalized, unsignalized, or stop-controlled intersections.

DESIGN GUIDANCE

- Bike lane symbol pavement markings should be used to identify the bike pocket and should be located a minimum of 50' apart.
- A dashed 4" white bike pocket stripe should be provided on both sides of the bike pocket beginning a minimum of 50 feet in advance of the intersection stop bar, with a preferred minimum of 100 feet in advance of the intersection stop bar.

- Green epoxy paint or colored pavement is recommended between the dashed stripes in areas of high right turn traffic volume.
- A solid 4" white stripe should be provided on both sides of the bike pocket extending a minimum of 20 feet from the stop bar.
- The bike lane pocket should have a minimum width of 4 feet; the preferred width is that of the approaching bike lane.

ADDITIONAL REFERENCES AND GUIDELINES

- AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.
- NACTO. *Urban Bikeway Design Guide*. 2014.

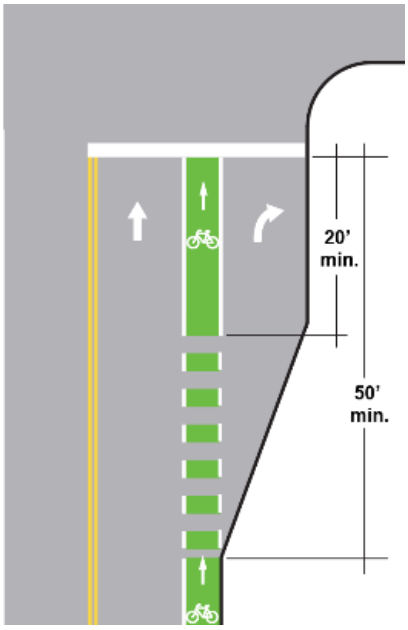


Figure 4-8: Bike lane pocket, bike lane adjacent to curb

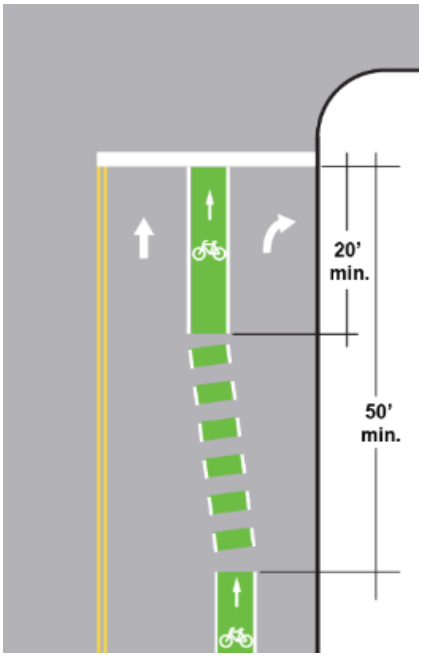


Figure 4-9: Bike lane pocket, bike lane adjacent to parking lane

4.3.3 BIKE BOXES

DESCRIPTION

Bike boxes are design treatments used at signalized intersections to provide a dedicated space for bicyclists to queue for left turns. Bike boxes help to enhance visibility of bicyclists by positioning bicyclists at the front of motor vehicle lanes to get ahead of queuing vehicles during the red signal phase.

Bike boxes are a valuable tool in improving intersection navigability for bicyclists. Hartford has only a few examples of marked bicycle boxes (Broad Street has bike boxes). Bicycle boxes should be a standard facility at signalized intersections where bicycle lanes, buffered bike lanes, and one-way separated bike lanes are provided. The can also be used with shared roadways. There are dozens of intersections in Hartford today that are good candidates for bike boxes.

Although bike boxes are used to enhance visibility, conflicts can still arise between bicyclists and motor vehicles. Conflicts can arise with motorists when a bicyclist arrives at the intersection as the traffic light is about to turn green for the corresponding approach. This conflict, however, can be somewhat mitigated by providing enough depth in the bike box. Additionally, bike boxes also have some limitations as they are not helpful for a left turning bicyclists when they arrive at the intersection when the traffic light is green.

APPLICATION GUIDANCE

- Bike boxes may be used with shared roadways, striped bike lanes, buffered bike lanes, and one-way separated bike lanes.
- Bike boxes should only be used at signalized intersections.
- Protected intersections or two-stage left turn boxes should be used in lieu of bike boxes on approaches with 3 or more thru and left turn traffic lanes.

DESIGN GUIDANCE

- Bike boxes typically should not be placed across more than two lanes of traffic due to the amount of lateral movement required of bicyclists to navigate a multi-lane bike box. These movements would take time and could potentially lead to conflicts between bicyclists and motorists when a bicyclist is arriving at a box as the signal is about to change.
- The bike box stop bar should be spaced between 1.5 and 3 feet from the crosswalk.
- Bike boxes should be a minimum of 10 feet deep. A bike box depth as much as 16 feet may be preferred on high bike volume corridors.
- A bicycle symbol pavement marking should be placed within the bike box to signify its use for bicyclists.
- Green colored pavement may be used within the bike box to enhance visibility, but is not required.
- A “Stop Here on Red” sign should be posted at the advance stop line, with an “Except Bicycles” sign to reinforce observance of the stop line.
- On approaches with combined thru-right traffic lanes, the restriction of right-turn on reds should be considered to allow bike movement within the box across the front of otherwise right-turning traffic.

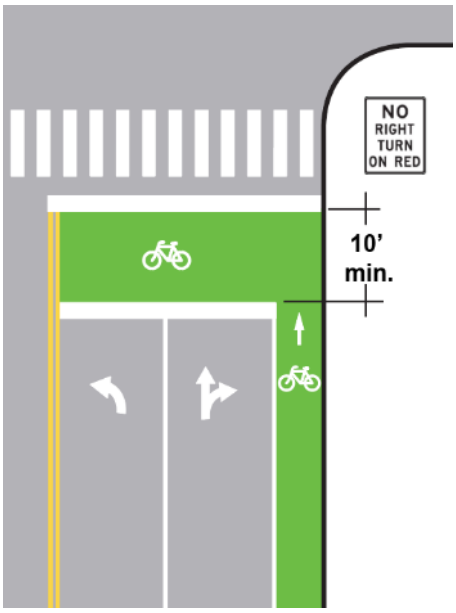


Figure 4-11: Bike box with a through-right traffic lane

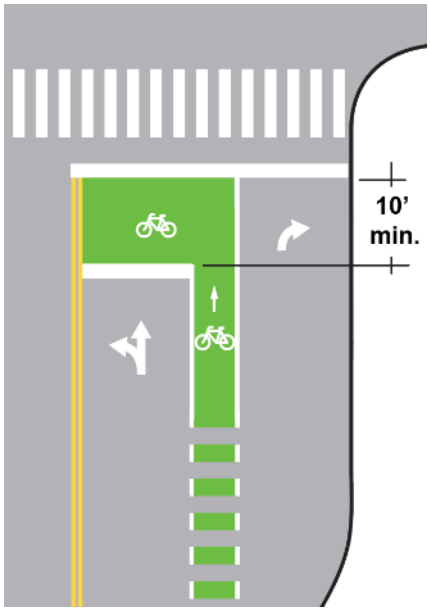


Figure 4-10: Bike box with a dedicated right turn traffic lane

ADDITIONAL REFERENCES AND GUIDELINES

- FHWA. *Interim Approval for Optional Use of an Intersection Bicycle Box (IA-18)*. 2017
- NACTO. *Urban Bikeway Design Guide*. 2014.

Figure 4-30: Typical bike box Source: City of Tucson, AZ

4.3.4 TWO STAGE LEFT TURN BOXES

DESCRIPTION

Two stage left turn boxes (left turn boxes) are intersection design treatments that help facilitate left turns for bicyclists. They offer bicyclists a safe alternative to making left turns at signalized intersections by splitting the turning movement into two separate through movements. This type of bicycle maneuver is permitted by Connecticut state law. The maneuver eliminates the need for the bicyclist to merge over into a left lane to make a left. The design treatment involves a through movement with a bicyclist stopping in a dedicated turn box that is typically placed on the far side of the intersection to the right of a traffic or bicycle lane. Once the bicyclist arrives at the dedicated turn box, they make a second through movement to complete their left turn. It should be noted that although two stage left turn boxes provide a safe alternative for making left turns at intersections, they also result in an increase in delay for bicyclists because they need to wait for two separate green signals to turn when located at a signalized intersection.

Hartford does not currently have left turn boxes. While this facility is not appropriate for all intersections with approaching bicycle facilities, there are existing locations in Hartford that would benefit from the provision of two-stage left turn boxes. The implementation of this facility type will require education and outreach to bicyclists to encourage proper use.

APPLICATION GUIDANCE

- May be used with shared roadways, striped bike lanes, buffered bike lanes, separated bike lanes, and sidepaths.
- May be used at signalized and unsignalized intersections.
- Should be considered for intersections where the approaching roadway has two or more thru and left turn traffic lanes in each direction or high traffic volumes and/or speeds.

DESIGN GUIDANCE

- Left turn boxes should be placed in a protected area outside the paths of moving vehicular traffic, typically between a crosswalk and bicycle or traffic lane.
- Right turns on red should be prohibited on the approach behind a left turn box and should be signed accordingly.
- Left turn boxes should be a minimum of 6 feet x 6 feet (8 feet x 8 feet preferred) and should be bordered by an 8-12” wide epoxy or thermoplastic white stripe.
- An epoxy paint or preformed thermoplastic bicycle symbol and turn arrow should be placed within the bike box to signify its use for bicyclists as well as to indicate proper bicycle direction and positioning.
- Green colored pavement, thermoplastic, or epoxy paint may be used within the left turn box to enhance visibility.

ADDITIONAL REFERENCES AND GUIDELINES

- FHWA. *Interim Approval for Optional Use of Two-Stage Bicycle Turn Boxes (IA-20).* 2016.
- NACTO. *Urban Bikeway Design Guide*. 2014.

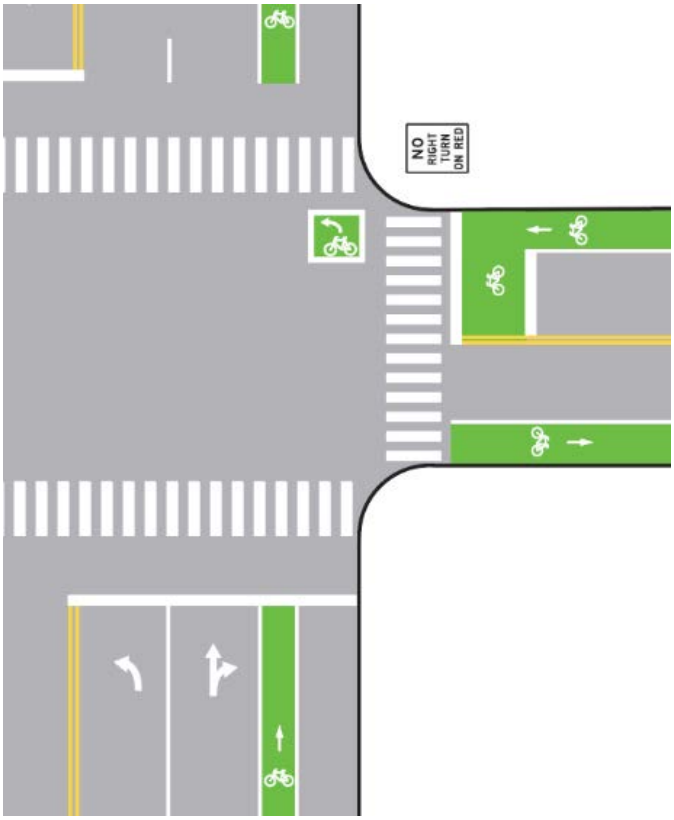


Figure 4-31: Two stage left turn box

Figure 4-32: Example of two stage left turn box, Portland, OR Source: NACTO 2014 Urban Bikeway Design Guide

4.3.5 PROTECTED INTERSECTIONS

DESCRIPTION

Protected intersections are an intersection design treatment that separates turning vehicles from crossing bicyclists and pedestrians with corner safety islands and setback bicycle crossings. In combination with traffic signal changes, they can improve cyclist safety in a few ways. First, they make bicyclists more visible. Second, they eliminate through bicyclist conflicts with turning motor vehicle traffic. They also provide space for left turning bicycles to position themselves for two stage left turns.

Protected intersections are a useful tool in situations where bicyclists would benefit from crossing intersections under a dedicated bicycle signal system or pedestrian phase. They are essential design features with two-way separated bike lanes, and often are beneficial to one-way separated bike lanes.

A protected intersection is currently being considered for the intersection of Sigourney Street and Farmington Avenue where planned bicycle lanes on Farmington Avenue intersect with the planned Sigourney Street separated bike lane. There are likely other locations in Hartford that could immediately benefit from the provision of a protected intersection. The drawbacks include the introduction of additional pedestrian and bicyclist conflict at crosswalks and curb ramps, the potential need for a separate bike signal phase, and additional snow removal maintenance requirements.

Figure 4-33: Protected intersection Source: Alta Planning

APPLICATION GUIDANCE

- May be used with buffered bike lanes, separated bike lanes, and sidepaths.
- May be used with bicycle boulevards, shared roadways, and striped bike lanes if the intersecting bicycle facility is a buffered bike lane, separated bike lane, or sidepath.

DESIGN GUIDANCE

- Protected intersections include the following design features:
    - Corner safety islands – raised areas that separate bike queuing areas from the motor vehicle travel lane.

  - Bicycle queuing area – the area at which bicyclists wait at the intersection.
  - Bicycle crossing setback – the bicycle and pedestrian crossings are set back from the adjacent motor vehicle travel lane.
  - Approach taper – the separated bike lane is shifted in advance of the intersection to align bicyclists with the bicycle crossing and provide queuing space for bicyclists.
- Each intersection treatment should be carefully evaluated and tailored to fit roadway and traffic conditions. The following are recommended dimensions of key intersection elements:
  - Radius of corner safety islands – 20 feet or greater based on design vehicle.
  - Corner island a minimum of 18 feet long by 4 feet wide (curb face to curb face)
  - A minimum 10 foot separation between apex of corner island and apex of sidewalk to allow a 5 foot wide clear path for right turning riders adjacent to a 5 foot wide clear path for left turning riders.
  - Bicycle queuing area – a minimum area of 8 feet x 6.5 feet with a bike lane symbol pavement marking to indicate bicyclist position and direction of travel.
- A shared pedestrian and bicycle signal phase may be used, but a separate bicycle signal phase is preferred.
- If an actuated signal phase is used, the signal actuator should be placed on the right side of the queuing area, 4 feet from the edge of roadway. Such placement allows riders to actuate the signal from the bicycle queuing area without dismounting.
- Right turns on red should be prohibited on all approaches so as to prevent right hook accidents and provide the highest level of safety for all users.
- Pedestrian crosswalk markings should be applied across the bike lane between sidewalks and sidewalk ramps. Tactile warning strips should be located within sidewalks on either side of the bike lane.
- Green epoxy paint or preformed thermoplastic bike crosswalk markings should be applied across the roadway between bike lanes. Bike crossing marking should be applied adjacent and parallel to pedestrian crosswalk markings and should have the same line thickness and spacing. Bike crosswalk markings should be a minimum of 6.5 feet wide.

ADDITIONAL REFERENCES AND GUIDELINES

- Alta. *Lessons Learned: Evolution of the Protected Intersection*. 2015.
- CROW. *Design Manual for Bicycle Traffic*. 2016.
- FHWA. *Separated Bike Lane and Planning Design Guide*. 2015.

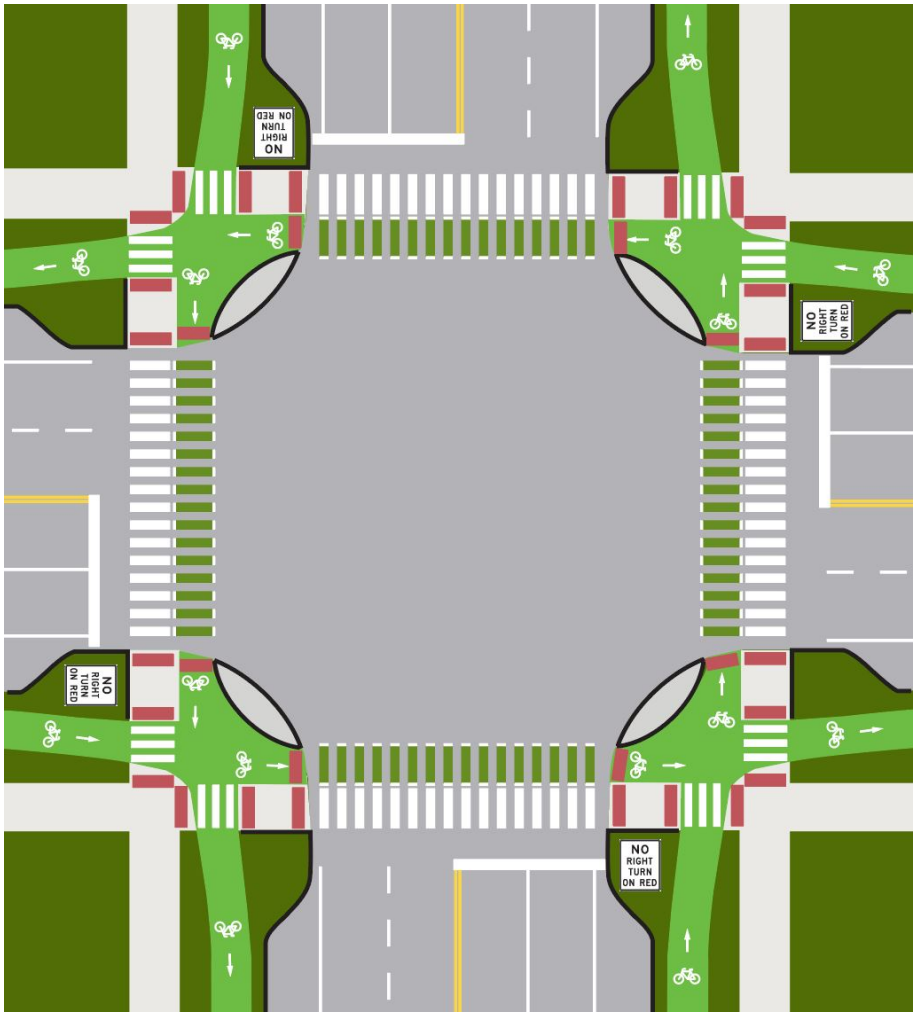


Figure 4-34: Typical protected intersection configuration

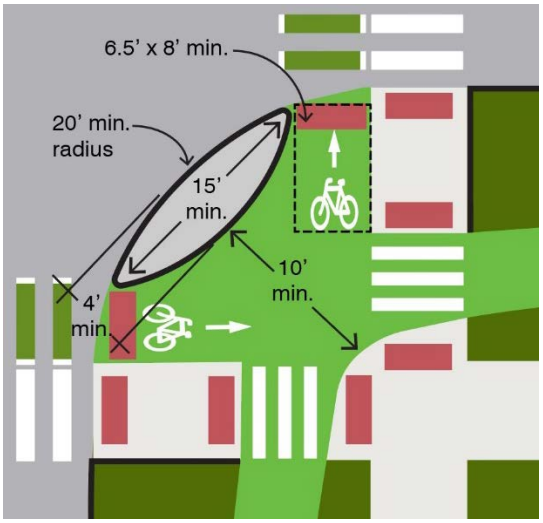


Figure 4-13: Geometric design of protected intersections

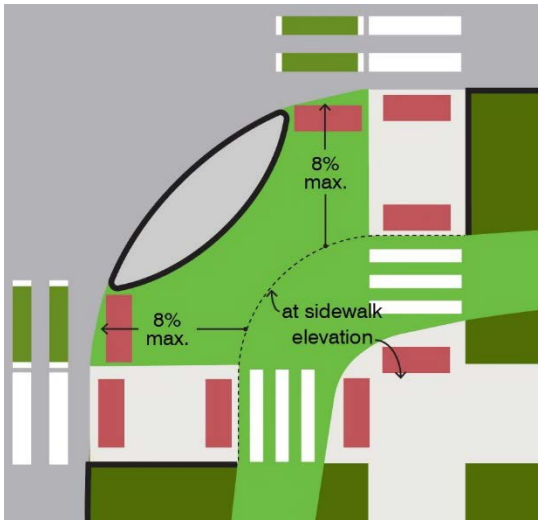


Figure 4-12: Recommended grading of protected intersections for Hartford

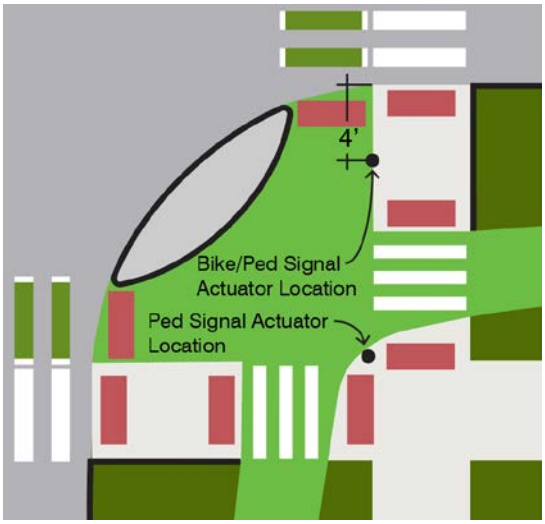


Figure 4-14: Signal actuator locations

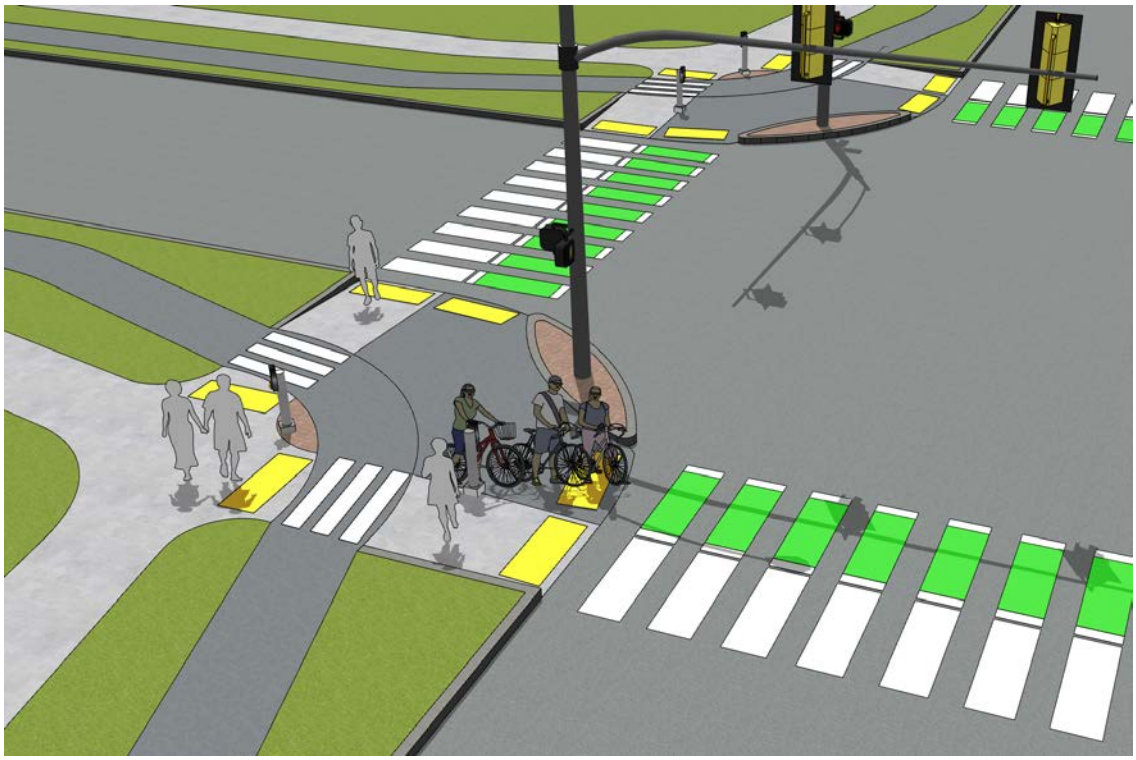


Figure 4-38: Typical protected intersection

MAINTENANCE

The maintenance of protected intersections is identified as a concern for many municipalities, including the City of Hartford, considering the implementation of these enhanced treatments. While they do require the use of smaller machines compared to conventional intersections, they can be successfully maintained year-round even in cities with significant snowfall.

Similar to the requirements for separated bike lanes, protected intersections should provide 6.5 feet clearance in all directions to accommodate smaller snow clearing machines. The internal radius of the corner island is generally designed to be greater than or equal to 16 feet (for cyclists), which can also accommodate most small snow clearing equipment. Some spot snow removal may be required adjacent to curbs. One strategy to reducing maintenance challenges is to raise the cycling portion of the intersection to the same level as the sidewalk to allow for clearing with sidewalk equipment in a single pass. An example of a protected intersection concept with the raised separated bike lane is shown in Figure 4-33. Despite the challenges associated with these intersections, municipalities with significant snowfall are building and maintaining these facilities year-round, including examples in Chicago, IL.

4.3.6 MEDIAN REFUGE ISLANDS

DESCRIPTION

Median refuge islands are designed to help facilitate roadway crossings for both bicyclists and pedestrians. They provide a protected space for bicyclists to wait as they cross one direction of traffic at a time. These design treatments can also be used to help calm traffic by physically narrowing the roadway.

Median refuge islands are typically used in mid-block locations where separated bike lanes, sidepaths, or shared-use pathways cross a roadway. See Figure 4-40. Median refuge islands can also be used to protect bike crossings at large multilane intersections where more than one crossing signal phase may be necessary. Median refuge islands may also be used as a traffic diversion device that prevents through motor vehicle traffic across an intersection while allowing through bicycle traffic. See Figure 4-39.

APPLICATION GUIDANCE

- May be used at signalized and unsignalized intersections
- May be used to assist mid-block crossing locations or intersection crossings with four or more traffic lanes.
- May be used as a traffic diversion device

DESIGN GUIDANCE

- Recommended minimum widths of median refuge islands is 6 feet, but 8 feet is preferred.
- Median refuge islands should have an opening wide enough for two bicyclists to comfortably pass through, which is 6.5 feet. If the bike crossing is paired with a pedestrian crossing, the opening should be a minimum of 12 feet.
- The island should be curb height, or approximately 6 inches high.
- The approach edge of a raised median refuge island should be outlined in retroreflective white or yellow material.
- Pavement markings on the approach should follow guidance provided in the 2009 FHWA MUTCD Section 31.02.

ADDITIONAL REFERENCES AND GUIDELINES

- FHWA. *Manual on Uniform Traffic Control Devices*. 2009.
- NACTO. *Urban Bikeway Design Guide*. 2014.

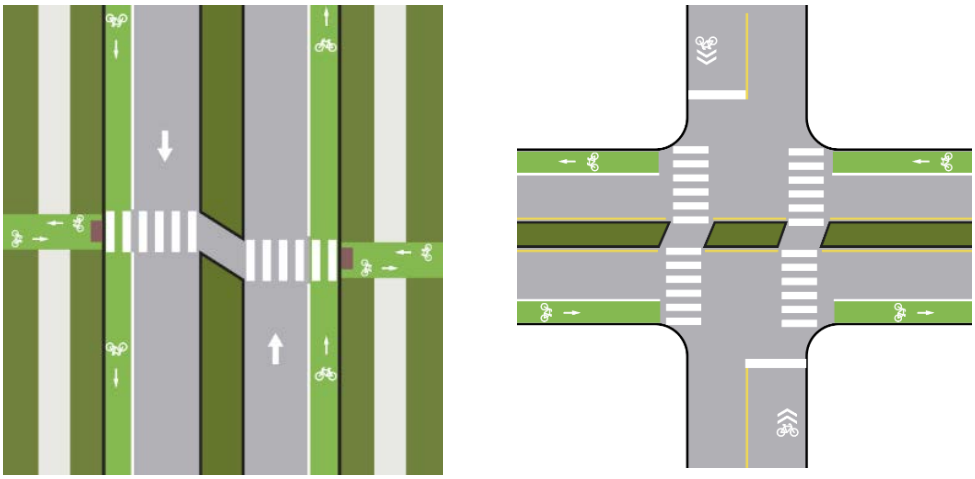


Figure 4-15: Median refuge islands: Mid-block pathway crossing (left), intersection application as a traffic diverter (right)

Figure 4-40: Median refuge island - Midblock implementation, Bellevue, WA Source: www.pedbikeimages.org - Dan Burden

4.3.7 INTERSECTION CROSSING MARKINGS

DESCRIPTION

Intersection Crossing Markings are various types of pavement markings that are applied within an intersection or across a roadway to guide bicyclists through the intersection and increase awareness of drivers. The specific marking types include:

- Intersection Sharrow Markings
- Dashed Stripes
- Dashed Green Markings

4.3.8 INTERSECTION SHARROW MARKINGS

APPLICATION GUIDANCE

- May be used within an intersection and is recommended for use on shared roadways and bicycle boulevard corridors.
- May be used at signalized and unsignalized intersections.
- Most effective when used within intersections where entering or crossing traffic is controlled by a stop sign and thru-bike traffic has the right-of-way.
- Can be effective for large complicated intersections to guide cyclists.

DESIGN GUIDANCE

- Apply one sharrow marking per crossing traffic lane.
- Center sharrow marking on the center of crossing traffic lanes.
- Place sharrow markings in line with sharrow or bike boulevard markings approaching and following the intersections.

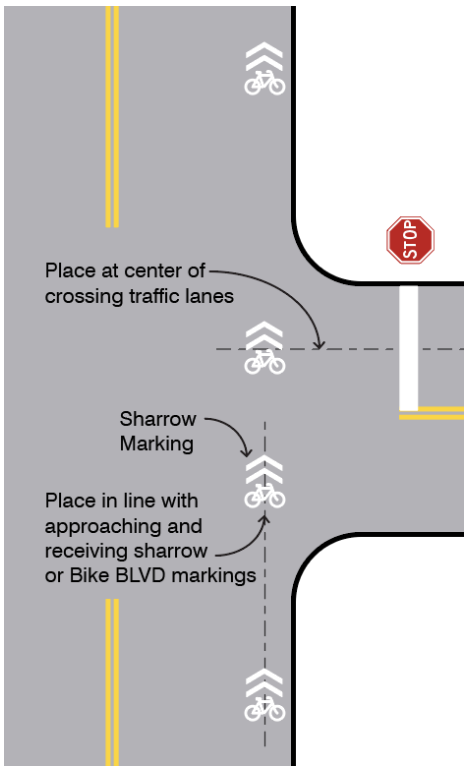


Figure 4-16: Intersection sharrow markings

4.3.9 DASHED STRIPES

APPLICATION GUIDANCE

- Recommended for use on corridors with striped bike lanes or buffered bike lanes.
- May be used at signalized and unsignalized intersections.
- Most effective when used at intersections where entering or crossing traffic is controlled by a stop sign and thru-bike traffic has the right-of-way.
- Also effective for large, complicated intersections to provide wayfinding

DESIGN GUIDANCE

- Dashed lines segments should be 2 feet long and spaced uniformly, 2 to 5 feet apart.
- The distance between the center of the two dashed lines should match the width of the approaching bike lane.
- Dashed line width should match the width of edge stripes of the approaching bike lane.
- Chevron symbols may be used within the dashed striped as a means of increasing conspicuity. Their use should be reserved for large, complex intersections. Chevrons should be spaced approximately 6 feet apart.
- White epoxy paint should be used for pavement markings.

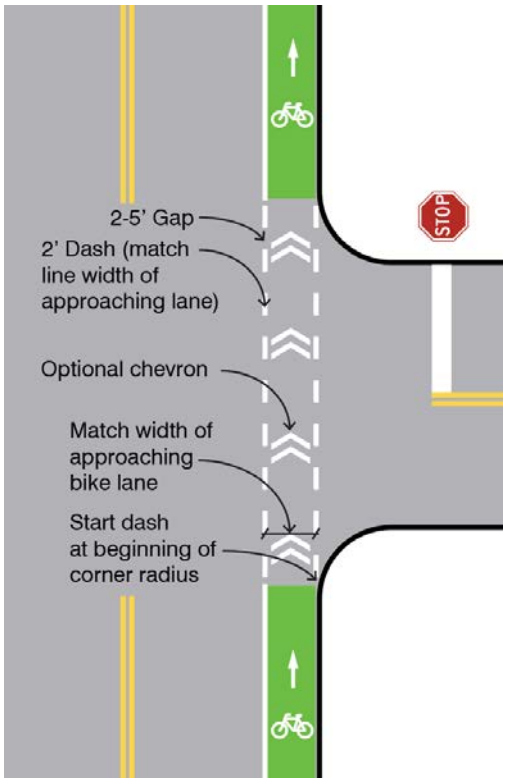


Figure 4-17: Dashed stripes

4.3.10 DASHED GREEN MARKINGS

APPLICATION GUIDANCE

- Should be used at intersection crossings of separated bike lanes.
- May be used at signalized and unsignalized intersections.

DESIGN GUIDANCE

- White, 6-inch dashed edge striped should be used.
- Edge stripes should be 2 feet long and spaced between 2 and 5 feet apart.
- Green pavement marking should extend between dashed edge stripes.
- The width of the dashed green marking, inclusive of edges stripes should match that of the approaching bike lane or bike lane ramp.
- When adjacent to a crosswalk, longitudinal crosswalk pavement markings should be aligned with dashed green markings, or vice versa.
- When adjacent to a crosswalk, the edge line of dashed green markings should be spaced a minimum of 6 inches from the edge of a crosswalk.
- Epoxy paint should be used.

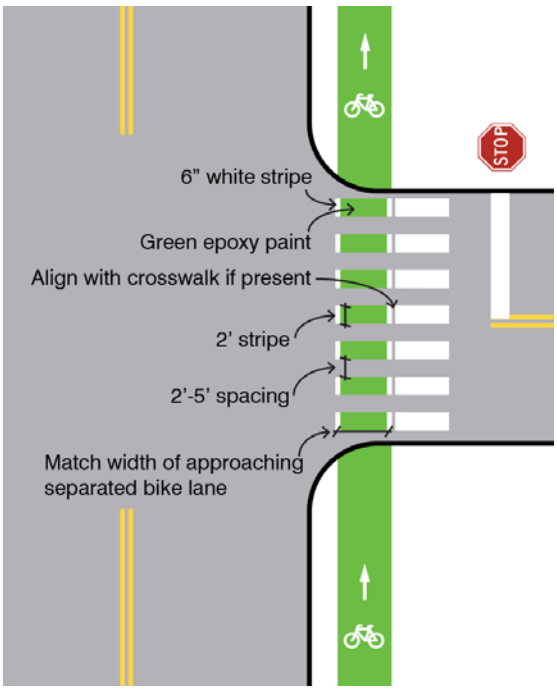


Figure 4-18: Dashed green markings

4.4 SPECIAL DESIGN CONSIDERATIONS

The introduction of bicycle facilities to a transportation network requires special consideration at potential points of conflict beyond conventional intersections. Within this section are design considerations for roundabouts, bus stops, and on-street parking.

4.4.1 ROUNDABOUT FACILITIES

The accommodation of bicyclists through roundabouts requires special consideration and the type of accommodation is subject to the size (one-lane or two-lane) and design speed of the roundabout. While small, single lane, low volume roundabouts are generally favorable to bicyclists due to low traffic speeds and low volumes which provide ample gaps in traffic, higher volume single lane roundabouts and larger, higher speed, multi-lane roundabouts require a side path or separated bike lane to safely and comfortably accommodate bicyclists through the intersection. Further, bicyclists of all ages and abilities will not be comfortable even in a low volume single lane roundabout. For that reason, it is recommended that ramps to wide sidepaths be provided at any roundabout installed in Hartford in the future.

No roundabouts currently exist in Hartford, but a roundabout is planned for the intersection of Sigourney Street and Park Terrace. This roundabout will feature separated bike lanes as a means of accommodating bicyclists. Additional locations such as the intersection of Albany Avenue and Main Street have been considered as candidates for a roundabout; the design of such facilities should ensure safe and comfortable bicycle access.

DESIGN GUIDANCE

- A maximum entry design speed between 15 to 19 mph is recommended for single lane roundabouts. Entry speeds of 20 to 23 mph are recommended for multi lane roundabouts.
- Sidepaths, 10 feet wide or greater, should be provided around the perimeter of the roundabout.
- Bike ramps leading to a wide sidepath should be provided for bicyclists who prefer not to navigate the roundabout on the roadway. Bike ramps should be installed a minimum of 50 feet in advance of the circulatory roadway.
- Bike lane striping should transition to dashed striping approximately 100 feet in advance of the circulatory roadway to signal bicyclists to share the circulatory roadway with motorists.

ADDITIONAL REFERENCES AND GUIDELINES

- AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.
- FHWA. *Roundabouts: An Informational Guide.* 2000.
- NACTO. *Urban Bikeway Design Guide*. 2014.

Figure 4-44: Example of bicycle ramp at roundabout facility Source: Custom Concrete

4.4.2 BUS STOPS

Although transit and bicycling are often considered complementary modes, their coexistence on roadways can present a significant challenge. Conflicts between the two modes typically arise due to their differences in size, average speed, stopping patterns, and competition for curb side space.

The 2012 AASHTO Guide for the Development of Bicycle Facilities provides some design guidance for the striping of bike lanes along roadways with near-side and far-side bus stops. The guide recommends bike lanes be dotted at near-side bus stops or bus pullouts in order to allow buses to merge into the bike lane to approach the bus stop. This design treatment is optional, however, for far-side bus stops. For far-side bus stops, the normal use of solid white lines is appropriate.

NACTO also provides additional design guidance for the treatment of far-side bus stops with bike lanes present. In its 2016 Transit Street Design Guide, NACTO recommends marking the bike lane to the left of the bus stop to allow bicyclists to travel through the intersection, while the bus is able to stop curb side. It should be noted, however, that this type of design only works with a curbside pull-out stop. The 2016 NACTO Transit Street Design Guide also recommends the follow design guidelines:

- *Exit taper is typically 25-40 feet. Enforcement should ensure stop areas remain unblocked by parking or loading.*
- *Platform length includes length of the bus plus 10 feet of clearance from back of vehicle to crosswalk.*
- *Mark the bike lane to the left of the bus stop; place concrete bus pad to the right of the bike lane.*

NACTO also recommends side boarding islands as an alternative to reducing conflicts between bicyclists and buses. Side boarding islands are dedicated passenger waiting areas for buses that are separated from the sidewalk by a bike channel. These boarding islands help eliminate conflicts by allowing bicyclists and buses to travel straight at the bus stop in their own dedicated lanes. The designs incorporate a boarding island away from the sidewalk for buses to stop as well as a bike channel that diverts bicycle traffic behind the bus stop to reduce conflicts. Consideration for side boarding islands should be considered at high volume transit stops where protected bike lanes and transit operations overlap. High volume transit stops generally have more than 200 boardings per weekday in the peak direction, but a specific figure for Hartford should be developed in cooperation with CTTransit.

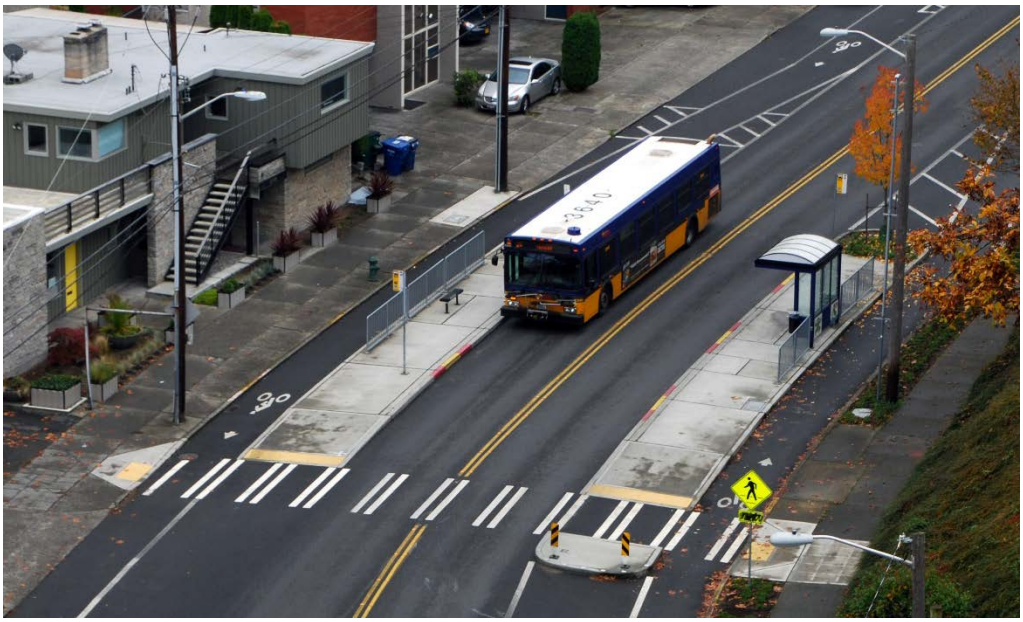


Figure 4-45: Bus stop island between roadway and separated bike lane Source: NACTO (Oran Viriyincy)

4.4.3 ON-STREET PARKING

Bicyclists often experience conflict with on-street parking when car doors suddenly open as passengers exit. Consideration should be given to minimizing this conflict between bicyclists and parked vehicles. When possible, a buffer is recommended to be provided between the on-street parking lane and the bicycle lane to guide bicyclists away from car doors. Design guidelines from NACTO, SDOT, OTM Book 18, and the City of Davidson provide recommended buffer widths between bicycle lanes and on-street parking as summarized in Table 13.

When right-of-way is constrained, local jurisdictions may be faced with the decision of where the striped buffer should be placed, whether it should be placed between the bike lane and the travel lane or between the bike lane and on-street parking. Under these circumstances, careful evaluation of the corridor and sound engineering judgement must be applied. Consideration must be given to a number of factors, such as traffic volumes, parking turn-over/occupancy, and collision history, in order to determine the most optimal placement of the striped buffer. For instance, on roadways where traffic volumes are high and parking turn-over/occupancy is low, the most optimal placement of the striped buffer would be between the bike lane and the travel lane.

MANUAL OR RESOURCE	RECOMMENDED BUFFER WIDTH
NACTO Urban Bikeway Design Guide	1.5 feet minimum
Ontario Traffic Manual Book 18	0.5 to 1 meter
Seattle Bicycle Master Plan	1 foot 8 inches minimum
WSDOT Roadway Bicycle Facilities Design Manual	2 to 3 feet
City of Davidson Active Transportation Plan	2 feet minimum
Denver Bikeway Design Guideline	2 to 3 feet

Table 13 RECOMMENDED BUFFER WIDTH FOR ON-STREET PARKING

Based upon the reviewed design guidelines, the following application and design guidance is recommended for Hartford:

- The combined width of the bicycle lane and adjacent parking lane shall be no less than 13 feet.
- A buffer is recommended for use between an on-street bike lane and parking lane in areas of high parking turnover such as metered spaces, time-limited spaces, and retail areas.
- The buffer should be between 2 and 3 feet wide when placed between an on-street bike lane and parking lane.
- The buffer should be 3 feet wide when placed between the parking lane and a separated bike lane.
- The parking lane may be reduced to 7 feet wide when paired with a buffer.

5 EXISTING CONDITIONS AND PREVIOUS PLANS

This section describes the existing conditions research that was completed including a review of the two key existing plans that included bicycle route elements. The research included information on the characteristics of the street network, existing bicycle facilities, transit connections, bicycle trip generators and attractors in the City, including schools, parks, major employment sites, proposed bike share stations, and neighborhood retail centers. This information provided a foundation on which to base the development of the preferred bicycle network for Hartford.

5.1 Existing bicycle facilities and other existing conditions

The City of Hartford has been actively planning for bicycle transportation and has implemented several bicycle facilities in the recent past. These existing facilities are incorporated into the Hartford Bicycle Master Plan and represent the first steps toward a citywide network. As part of the existing conditions research, the following data was collected and mapped:

- Existing bicycle facilities: including on and off-street facilities and park circulation.
- Functional roadway class: A national classification of roadways into classes such as local roadways, collector roadways, minor arterial roadways, and principal arterial roadways. Provided by the Connecticut Department of Transportation (CTDOT).
- Average daily traffic volume: Available for selective roadways. Data sourced from CTDOT and the City of Hartford.
- 85th percentile traffic speeds: Available for selective roadways. Year 2000-2003 data available from the City of Hartford.
- Right-of-way width: Calculated and mapped from City of Hartford GIS data.
- Roadway width (curb to curb): Calculated and mapped from City of Hartford GIS data.
- Location of on-street parking: Mapped from City of Hartford GIS data and Google Earth imagery.
- Bicycle and pedestrian crash locations: Provided by the City of Hartford.
- Locations of probable bicycle activity generators and attractors: Mapped from City of Hartford GIS data and Google Earth imagery.

5.2 Consolidating Existing Bike Plans

Hartford had a limited number of plans that specifically addressed the need for improved bicycle facilities throughout the city. The most developed was the Capitol City Parks Guide (Parks Plan – see Table 14 and Figure 5-1), which proposed a series of bicycle facilities through and connecting to major parks. Additional plans included Hartford's 2016 revised zoning regulations that included requirements for bicycle facilities for new development, and provided a map of streets that should be prioritized for the provisions of bicycle facilities. This map is shown in Figure 5-2. The Hartford Bicycle Master Plan considered these proposals in its recommendations. Existing bicycle facilities are shown in Figure 5-3.

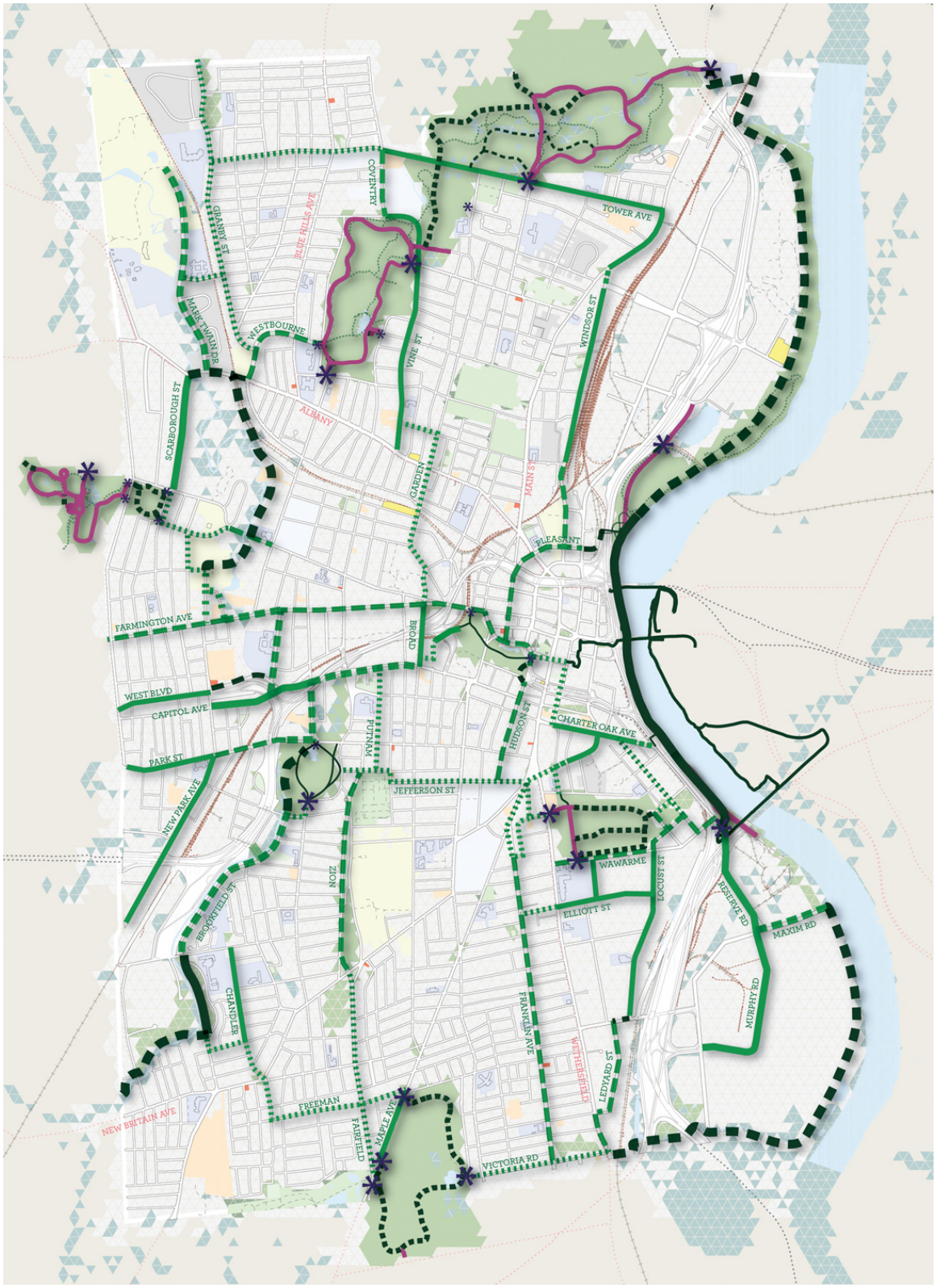


Figure 5-1: Parks Plan bicycle map.

Figure 5-2: City of Hartford zoning code bicycle lanes and tracks.

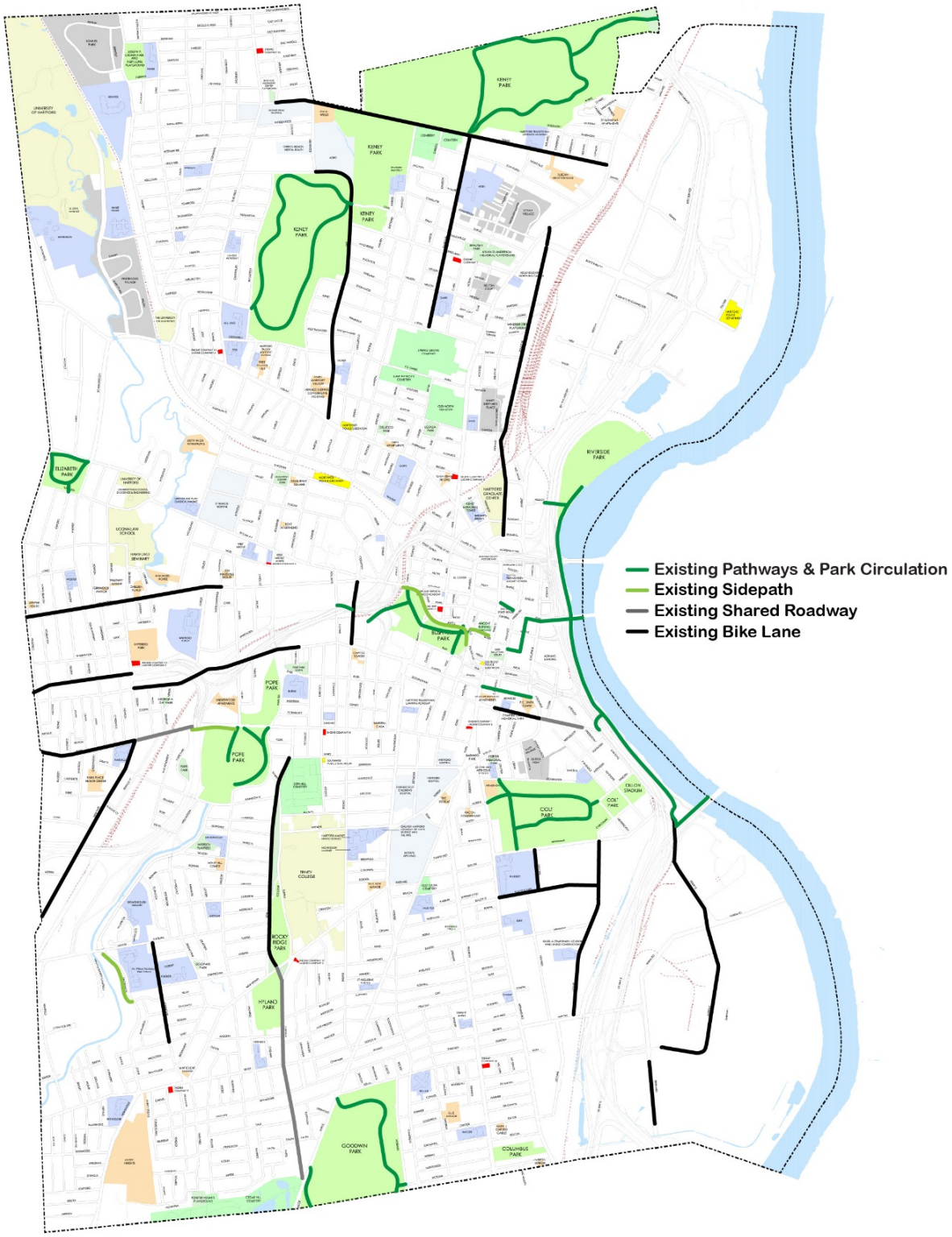


Figure 5-3: Existing bicycle facilities

While these existing plans were informative to the planning process, the bicycle master plan took a more comprehensive approach that considered a boarder range of facility types and resulted in a larger city-wide network of bikeways. For example, prior plans did not consider the use of separated bike lanes, nor did they provide guidance for the provision of intersection facilities. In general, where facility types differ in recommendation, the Hartford Bicycle Master Plan recommends more robust or protective facilities than do the existing plans.

The Hartford Bicycle Master Plan otherwise builds on a number of initiatives including the Parks Plan bicycle network and the existing program for speed hump requests (through neighborhood organizations), which serves as a model for bike boulevard establishment.

Table 14: Parks Plan Recommendations

Street	Recommended 2013 Parks Plan Bike Facility
Afflek Street	Shared Roadway
Airport Road	Sidepath/Shared Use Pathway
Albany Avenue	Sidepath/Shared Use Pathway
Annawan Street	Shared Roadway
Asylum Avenue	Sidepath/Shared Use Pathway
Asylum St	Sidepath/Shared Use Pathway
Brookfield Street	Bike Lane or Sidepath/Shared Use Pathway
Brookfield Street	Shared Roadway
Buckingham Street	Shared Roadway
Capitol Avenue	Bike Lane
Chandler Street	Shared Roadway
Cogswell Street	Shared Roadway/Bike Lane
Congress Street	Shared Roadway
Coventry Street	Bike Lane
Curcombe Street	Shared Roadway
Dart Street	Shared Roadway
Dean Street	Shared Roadway
Elizabeth Street	Shared Roadway
Elliot Street	Shared Roadway
Fairfield Street	Shared Roadway
Farmington Avenue	Bike Lane
Ford/Jewell/Trumbull	Shared Roadway
Forest Street	Bike Lane
Franklin Avenue	Bike Lane
Freeman Street	Shared Roadway
Garden Street	Shared Roadway
Girard Street	Shared Roadway
Gold Street	Shared Roadway
Granby Street	Shared Roadway
Groton Street	Shared Roadway

Street	Recommended 2013 Parks Plan Bike Facility
Hamilton Street	Shared Roadway
Harvard Street	Shared Roadway
Hendricxsen Avenue	Shared Roadway
Hillside Avenue	Shared Roadway
Hudson Street	Shared Roadway
Huyshope Avenue	Shared Roadway
Jefferson Street	Shared Roadway
Laurel Street	Bike Lane
Ledyard Street	Bike Lane
Lorraine Street	Shared Roadway
Maple Avenue	Bike Lane
Mark Twain Drive	Bike Lane
Masseek St	Shared Roadway
Mather Street	Shared Roadway
Maxim Road	Bike Lane
Morris Street	Shared Roadway
Park Street	Bike Lane
Park Street	Shared Roadway
Park Terrace	Shared Roadway
Plainfield Street	Shared Roadway
Pleasant Street	Bike Lane
Prospect Street	Shared Roadway
Pulaski Circle	Sidepath/Shared Use Pathway
Putnam Street	Shared Roadway
Reserve Road	Bike Lane
Sequassen Street	Shared Roadway
Sherman Street	Shared Roadway
Sisson Avenue	Sidepath/Shared Use Pathway
South Prospect St	Shared Roadway
Tower Avenue	Shared Roadway
Tower Square	Shared Roadway
Trumbull Street	Shared Roadway
Trumbull Street	Bike Lane
Victoria Road	Shared Roadway
Ward Street	Shared Roadway
Wawarme Street	Bike Lane
Wawarme Street	Shared Roadway
Westbourne Parkway	Bike Lane
Wethersfield Avenue	Bike Lane

Street	Recommended 2013 Parks Plan Bike Facility
Whitney Street	Shared Roadway
Windsor Street	Bike Lane
Wyllys Street	Bike Lane
Wyllys Street	Shared Roadway
Zion Street	Bike Lane

5.3 Transit rich corridors and key bus stops

The preferred bicycle network is intended to work with transit routes with higher service levels in Hartford to increase transit ridership and the effective mobility range of bicyclists. The City's fixed guideway transit stations (CT*rail* and CT*fastrak)* present the richest opportunities for improved bicycle access. CT*transit* also operates a network of standard transit routes throughout the city, many of which include stops that are highly patronized. Expanding access to these stations and stops via bicycle will greatly increase the effectiveness of both modes. These locations were mapped and primary access corridors identified. Important connecting points between the bicycle and transit systems are shown in Figure 5-4.

5.4 Bicycle trip generators and attractors and gap analysis

A "heat map" of bicycle activity generators and attractors was developed. The goal of this effort was to identify areas within the City that are likely to have a high demand for bicycle facilities. Locations mapped include:

- Corporate campuses
- High density housing
- Hospitals
- Major parks
- Schools
- Major venues
- Transit stations
- High activity bus stops
- Universities
- Retail corridors

The generator and attractor heat map is shown in Figure 5-5.

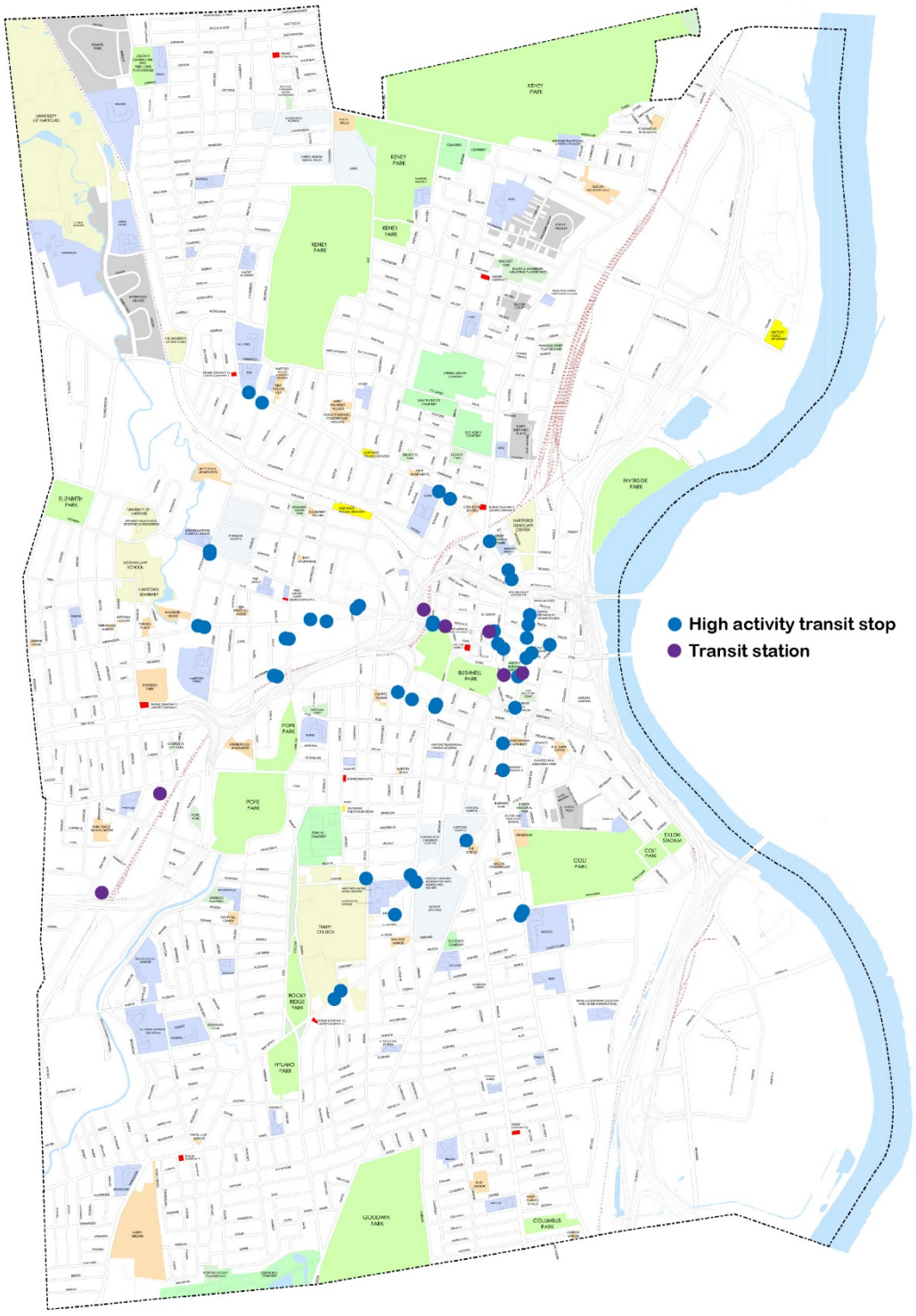


Figure 5-4: Major transit stations and high activity stops along transit rich corridors.

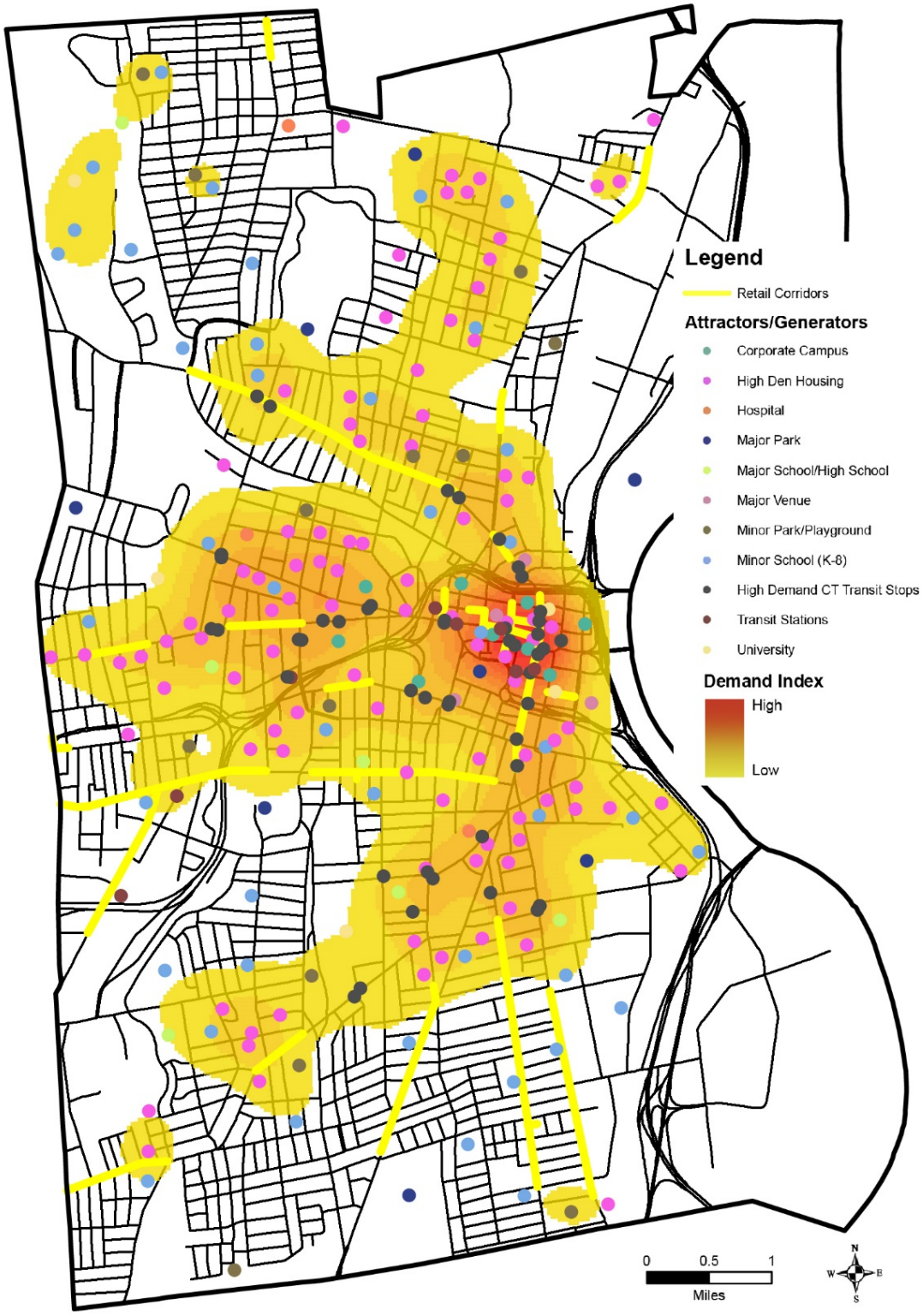


Figure 5-5: Heat map of generators and attractors.

Based upon this analysis, the greatest areas of demand include the Downtown and Asylum Hill, other areas of high demand include the Clay Arsenal, Upper Albany, Northeast, Frog Hollow, South Green, Sheldon/Charter Oak, and Barry Square neighborhoods.

The map also revealed gaps in the existing bicycle network where high demand is not served by the existing bicycle network. Most obvious gaps in the existing bicycle network were in central Hartford in and near downtown as shown in network. Other gaps included the northwest part of the city and major corridors such as Franklin, New Britain, Wethersfield, Main, and Albany.

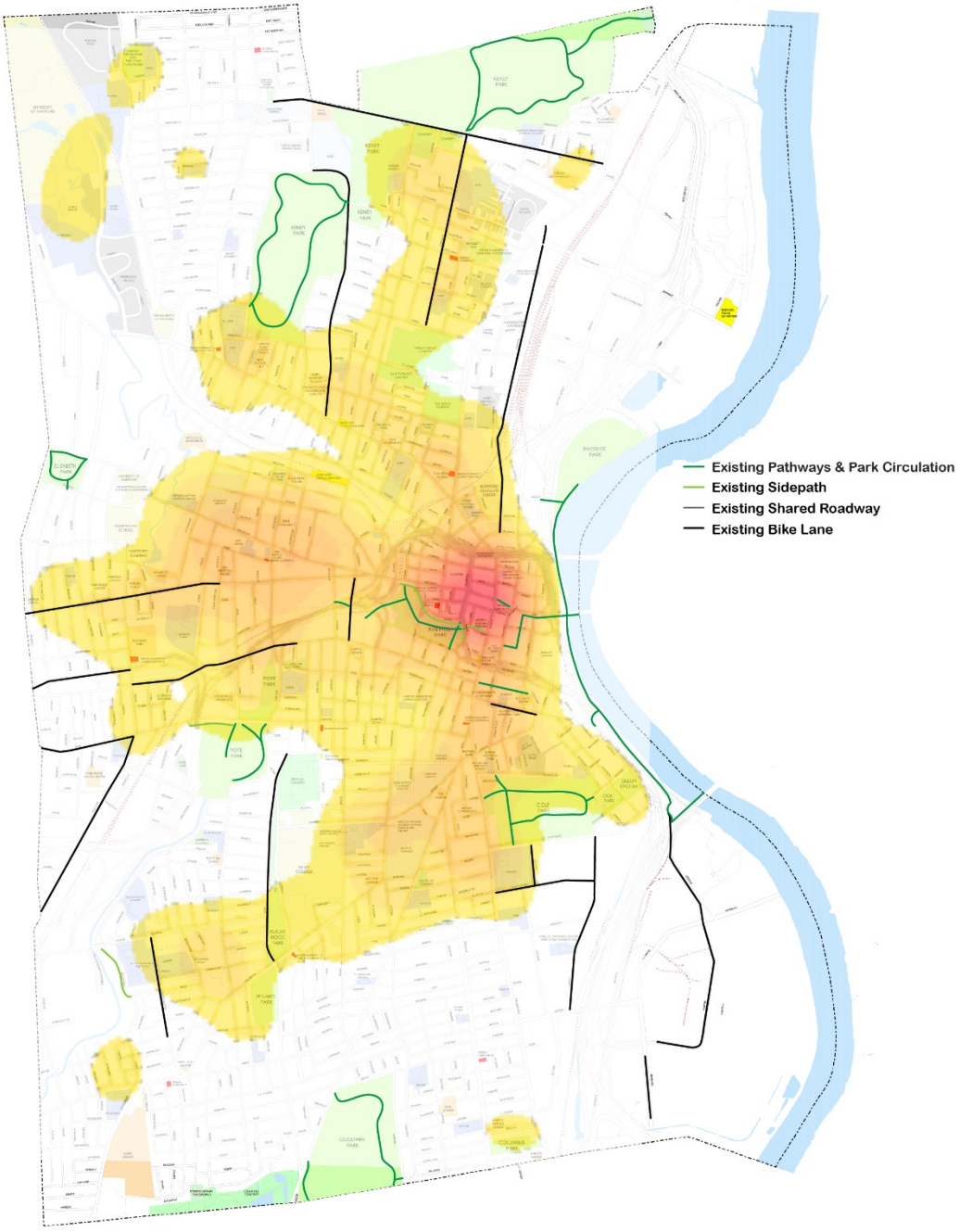


Figure 5-6: Generator and attractor heat map with existing Hartford bicycle network.

6 FINAL PLAN AND RECOMMENDATIONS

This section describes the approach taken to develop the final plan from the selection guidelines, design guidelines, existing conditions research, previous plans, and other work previously completed. The plan was carefully developed based on the needs of the City, proven techniques for the design of safe and efficient bike facilities, and input from stakeholders and the public. The goal is to eventually implement a network of bikeways that tie the entire city together giving bicyclists the same level of accessibility as motorists currently enjoy. It will create a network that is comfortable for a wide variety of bicyclists including those who are young, older, or just beginning as well as those who are more accomplished.

6.1 Approach

As a city with 123,000 residents and the equivalent number of jobs, there is a demand (which may be latent) for bicycle facilities throughout the City of Hartford. Currently, only 8% of Hartford's local street network has bicycle facilities. This equates to 16 miles of Hartford's 205 miles of local streets. Most of that network, 14.6 miles, is comprised of standard bicycle lanes, while the balance includes sidepaths and sharrows. Much of this network was developed as an outcome of road diet measures. As such, many of the corridors which had capacity to accommodate bicycle lanes have already been built out. Providing bicycle accommodations on many of the city's remaining corridors will require innovative design and may require a reduction in traffic lane width, traffic lanes, parking lanes, relocation of curbs and sidewalks, and/or property easements and expansion of right-of-way. Additionally, there are few intersection treatments for bicyclists in Hartford; for example, there are only two bike boxes in the city. Intersection treatments for bicyclists are needed along existing corridors and should be incorporated along all proposed bike corridors.

Therefore, the goal of bicycle network development process was to recommend a bicycle network that connects all areas of the City including the downtown, residential neighborhoods, and commercial and industrial areas. In support of this goal, there was a strong emphasis placed upon recommending a network that is physically, operationally, and fiscally feasible for the City to implement in the near term as well as the medium and long term.

1. Established a base network based upon functional classification. All collector and arterial roadways were identified as preferred bicycle corridors due to the presence of high bicycle activity generators and attractors located on these corridors and the level of connectivity that these corridors provide throughout the city. Facility type was not identified at this stage of the network development.
2. Identified priority corridors on local streets (a defined by functional classification) that provide connections in "gap" areas of the collector and arterial roadway system, or as alternate routes parallel to high traffic corridors.
3. Base network was compared against the heat map and crash incident map. Additional local street corridors were recommended based upon demand and need.
4. Selected facility type for each corridor based upon traffic volume and traffic speed as identified in the selection guide. The "preferred" facility type was initially selected for each corridor.
5. Revised recommended facility types based upon the physical capacity of the roadway or right-of-way. Of note:

    Where on-street facilities were recommended, the approach was to establish the feasibility of accommodating that facility within the existing roadway, without relocating curbs. The feasibility of eliminating on-street parking, reducing the number of traffic lanes, and reducing traffic lane width was considered.

Where off-street facilities were recommended, the approach was to establish the feasibility of accommodating those facilities within the existing pedestrian realm: the space off of the roadway but within the right-of-way. Considerations included the presence of utility structures, existing sidewalks, and other features in that realm.

Where conditions did not support the "preferred" facility type, "acceptable" or "provisional" facility types were selected.

Where conditions did not support the recommendation of a preferred, acceptable, or provisional facility type, the corridor was either removed from the bicycle network or recommended with the understanding that the development of that facility will require significant modifications to the roadway that may include relocation of the curb line and associated impacts to drainage and other utility structures.

A number of facilities, mostly separated bicycle lanes, that were recommended will require costly and impactful modifications to the roadway and/or will require expansion of the right-of-way. These corridors and the respective facilities were selected due to their strategic importance to the bicycle network. These corridors include, but are not limited to:

- Asylum Avenue
- Columbus Boulevard
- Main Street
- New Britain Avenue
- Sisson Avenue
- Washington Street
- Wethersfield Avenue
- Whitney Street
- Woodland Street

Other facilities can be implemented without significant modification of the roadway but will require the elimination of parking from one or both sides of the street in areas where on-street parking is heavily utilized. These corridors and the respective facilities were also selected due to their strategic importance to the bicycle network. These corridors include, but are not limited to:

- Capitol Avenue
- Church Street
- Elm Street
- Hudson Street
- Jefferson Street

6. Public feedback was incorporated into the recommended bicycle network. A map of the recommended bicycle network was distributed via email to key stakeholders and distributed to members of the City's Complete Street Committee. Two public meetings were conducted and feedback was received at, and following, those events. Comments received are included in Appendix A. Minor changes were made to the recommended network based upon this feedback. All changes were consistent with the standards established with the facility selection guide.
7. The plan proposes that an early win bicycle boulevard project be implemented along local streets such as North Beacon Street in concert with a traffic calming project recently

implemented along the same street segment. This would not only calm traffic and implement a bicycle facility but would also reduce traffic speeds to the recommended 85th percentile speeds for a bicycle boulevard. The City should also consider using "road diets" through the use of temporary pavement markings and physical buffers as a means of providing temporary bicycle facilities on roads which have four or more traffic lanes which are not required by the existing traffic volumes. By example, Wawarme Avenue may be good candidate. Likewise, the City could explore the provision of temporary bike lanes through the restriction of parking on one or both sides of a street. Multiple blocks of Homestead avenue may be suitable for this type of treatment.

6.2 Recommendations

The resulting network provides comprehensive coverage to the entire city, to all major corridors, and all neighborhoods. The preferred bicycle network is shown in list format in Table 15 and in map format in Figure 6-1. As pointed out above some corridors will be more difficult to implement than others and so will likely take more time to work through the planning and design process. Others will be fairly straightforward and non-controversial and can be completed more quickly. The plan deliberately includes both types so that the individual projects can move forward at a natural pace based on their complexity. Focusing on the practical first will allow more projects to be completed sooner, provide more benefits sooner than other approaches. In the next chapter the implementation plan will go into greater detail on roughly when any specific project may be implemented.

Table 15: Recommendations of 2018 Hartford Bicycle Master Plan

Street	Sector	Proposed Facility
AFFLECK ST	Central	Bike Boulevard
AIRPORT RD	South	Sidepath
ALBANY AVE	Central	Sidepath
ALLEN PL	South	Bike Boulevard
ALLYN ST	Central	Shared Roadway
ANN UCCELLO ST	Central	Bike Lane
ANN UCCELLO ST	Central	Shared Roadway
ANNAWAN ST	South	Bike Boulevard
ARCH ST	Central	Bike Lane
ARCH ST	Central	Shared Roadway
ASHLEY ST	Central	Bike Boulevard
ASYLUM AV	Central	1-Way Paired Separated Bike Lane
ASYLUM PL	Central	Shared Roadway
ASYLUM ST	Central	1-Way Paired Separated Bike Lane
ASYLUM ST	Central	Bike Lane
ATHENEUM SQ NORTH	Central	Shared Roadway
BABCOCK ST	South	Bike Boulevard
BARKER ST	South	Bike Boulevard
BARNARD ST	South	Shared Roadway
BEACON ST	Central	Bike Boulevard

Street	Sector	Proposed Facility
BLOOMFIELD AVE	Central	Sidepath
BLUE HILLS AVE	North	Bike Lane
BOB STEELE ST	Central	Shared Roadway
BOCE BARLOW WAY	North	Sidepath
BRAINARD RD	South	Bike Lane
BRAINARD RD	South	Buffered Bike Lane
BRAINARD RD	South	Sidepath
BROAD ST	South	Shared Roadway
BROADVIEW TER	South	Bike Boulevard
BROOKFIELD ST	South	Sidepath
BUCKINGHAM ST	Central	Shared Roadway
BULKELEY AV	Central	Bike Boulevard
BURNHAM ST	North	Bike Boulevard
CAMPFIELD AV	South	Shared Roadway
CAPEN ST	North	Shared Roadway
CAPITOL AV	Central	1-Way Paired Separated Bike Lane
CAPITOL AV	Central	Bike Lane
CAPITOL AV	Central	Bike Lane
CATHERINE ST	South	Bike Boulevard
CHANDLER ST	South	Bike Lane
CHAPEL ST NORTH	Central	1-Way Paired Separated Bike Lane
CHAPEL ST SOUTH	Central	1-Way Paired Separated Bike Lane
CHARLOTTE ST	North	Shared Roadway
CHARTER OAK AV	Central	Bike Lane
CHURCH ST	Central	Shared Roadway
COGSWELL ST	Central	Sidepath
COLLEGE TER	South	Sidepath
COLUMBUS BLVD	Central	1-Way Paired Separated Bike Lane
CONGRESS ST	South	Bike Boulevard
CORNWALL ST	North	Bike Lane
COVENTRY ST	North	Bike Lane
CRRA SITE	South	Shared Use Pathway
DEAN ST	South	Bike Boulevard
EAST BURNHAM ST	North	Bike Boulevard
EASTFORD ST	North	Bike Boulevard
EDGEWOOD ST	North	Bike Boulevard
EDWARDS ST	Central	Bike Lane
ELIZABETH ST	Central	Bike Boulevard
ELIZABETH ST	Central	Shared Roadway

Street	Sector	Proposed Facility
ELM ST	Central	Bike Lane
ENFIELD ST	North	Bike Boulevard
F D OATES AV	North	Bike Lane
FAIRFIELD AV	South	Bike Lane
FARMINGTON AV	Central	Buffered Bike Lane
FERN ST	Central	Shared Roadway
FLATBUSH AV	South	Bike Lane
FLATBUSH AV	South	Buffered Bike Lane
FLATBUSH AV	South	Sidepath
FLOWER ST	Central	Shared Roadway
FORD ST	Central	Shared Roadway
FOREST ST	Central	Bike Lane
FRANKLIN AV	South	Bike Lane
FRASER PL	Central	Bike Lane
FREEMAN ST	South	Bike Boulevard
GARDEN ST	North	Bike Lane
GARDEN ST	North	Shared Roadway
GARDEN ST	North	Sidepath
GOLD ST	Central	Shared Roadway
GRANBY ST	North	Bike Lane
GREENFIELD ST	North	Bike Lane
HAMILTON ST	South	Bike Lane
HAMILTON ST	South	Shared Roadway
HARTFORD HIGH SCHOOL	Central	Shared Use Pathway
HARVARD ST	South	Bike Boulevard
HAYNES ST	Central	Shared Roadway
HENDRICXSEN AVE	South	Bike Boulevard
HENRY ST	South	Bike Boulevard
HIGH ST	Central	2-Way Separated Bike Lane
HIGH ST	Central	Bike Lane
HIGH ST	Central	Shared Roadway
HILLSIDE AV	South	Bike Lane
HILLSIDE AV	South	Shared Roadway
HOLCOMB ST	North	Bike Lane
HOLCOMB ST	North	Shared Roadway
HOMESTEAD AV	North	1-Way Paired Separated Bike Lane
HOMESTEAD AV	North	Buffered Bike Lane
HUDSON ST	Central	Shared Roadway
IRVING ST	North	Bike Boulevard
JEFFERSON ST	South	Bike Lane
JEFFERSON ST	South	Shared Roadway

Street	Sector	Proposed Facility
JENNINGS ROAD	North	Sidepath
JEWELL ST	Central	Shared Roadway
KENEY PARK	North	Shared Use Pathway
KENEY TER	North	Bike Boulevard
KENSINGTON ST	North	Shared Roadway
KIBBE ST	Central	Bike Boulevard
LAUREL ST	Central	Bike Lane
LEDYARD ST	South	Buffered Bike Lane
LEIBERT RD	North	Shared Roadway
LEWIS ST	Central	Shared Roadway
LOVE LA	North	Bike Boulevard
LYME ST	North	Bike Boulevard
MAHL AV	North	Bike Lane
MAIN ST	Central	1-Way Paired Separated Bike Lane
MAPLE AV	South	1-Way Paired Separated Bike Lane
MAPLE AV	South	Bike Lane
MARK TWAIN DR	Central	Sidepath
MARKET ST	Central	2-Way Separated Bike Lane
MARKET ST	Central	Shared Roadway
MARKET ST	Central	Sidepath
MASSEK ST	South	Bike Boulevard
MAXIM RD	South	Bike Lane
MAXIM RD	South	Buffered Bike Lane
MEADOW ST	South	Bike Lane
MONTROSE ST	South	Bike Boulevard
MORGAN ST	Central	1-Way Paired Separated Bike Lane
MORRIS ST	South	Bike Boulevard
MOUNTFORD ST	South	Bike Boulevard
MURPHY RD	South	Bike Lane
MYRTLE ST	Central	Bike Lane
MYRTLE ST	Central	Shared Roadway
NEPAQUASH ST	South	Bike Boulevard
NEW BRITAIN AV	South	1-Way Paired Separated Bike Lane
NEWFIELD AV	South	Buffered Bike Lane
NEWINGTON AV	South	Sidepath
NORTH BEACON ST	Central	Bike Boulevard
NORTH BRANCH PARK RIVER	Central	Shared Use Pathway
NORTH CT RIVERFRONT	North	Shared Use Pathway

Street	Sector	Proposed Facility
PALM ST	North	Bike Boulevard
PARK ST	Central	Bike Lane
PARK ST	Central	Sidepath
PARK TER	South	Bike Lane
PARK TER	Central	Sidepath
PEARL ST	Central	Shared Roadway
PEQUOT ST	Central	Sidepath
PLAINFIELD ST	Central	Bike Lane
PLAINFIELD ST	North	Shared Roadway
PLEASANT ST	Central	Bike Lane
POPE PARK DR	South	Shared Use Pathway
POPE PARK HWY NO 4	Central	Sidepath
PRATT ST	Central	Bike Boulevard
PRESTON ST	South	Shared Roadway
PROSPECT AV	Central	Bike Lane
PROSPECT ST	Central	Shared Roadway
PULASKI CIR	Central	Sidepath
RESERVE RD	South	Bike Lane
RETREAT AV	South	1-Way Paired Separated Bike Lane
REV R A MOODY OVERPASS	North	Sidepath
RIDGEFIELD ST	North	Sidepath
RIVERSIDE PARK	North	Bike Lane
ROWE AV	Central	Bike Boulevard
SAYBROOKE ST	South	Bike Boulevard
SCARBOROUGH ST	Central	Buffered Bike Lane
SHELDON ST	Central	Bike Lane
SHELDON ST	Central	Shared Roadway
SHERMAN ST	Central	Shared Roadway
SHULTAS PL	South	Shared Roadway
SIGOURNEY ST	Central	2-Way Separated Bike Lane
SIGOURNEY ST	Central	Bike Lane
SIGOURNEY ST	North	Shared Roadway
SISSON AV	Central	1-Way Paired Separated Bike Lane
SOUTH CT RIVERFRONT	South	Shared Use Pathway
SOUTH PROSPECT ST	Central	Shared Roadway
SOUTH ST	South	Shared Roadway
SOUTH WHITNEY ST	Central	Shared Roadway
SPRING ST	Central	Bike Lane
SPRING ST	Central	Sidepath
SPRUCE ST	Central	Shared Roadway

Street	Sector	Proposed Facility
STAFFORD ST	South	Bike Boulevard
STONE ST	South	Bike Lane
SUMMIT ST	South	Bike Boulevard
SUMMIT ST	South	Bike Lane
TALCOTT ST	Central	1-Way Paired Separated Bike Lane
TAYLOR ST	Central	Shared Roadway
TEMPLE ST	Central	Shared Roadway
TERRY RD	Central	Bike Boulevard
TOWER AV	North	Shared Roadway
TRINITY CUT OFF	Central	Bike Lane
TRINITY ST	Central	Bike Lane
TRUMBULL ST	Central	Bike Lane
TRUMBULL ST	Central	Shared Roadway
UNION PL	Central	Shared Roadway
VAN BLOCK AVE	South	Bike Boulevard
VAN DYKE AV	North	Bike Lane
VERNON ST	South	Shared Roadway
VICTORIA RD	South	Bike Boulevard
WALNUT ST	Central	Buffered Bike Lane
WARD ST	South	Shared Roadway
WASHINGTON ST	South/ Central	1-Way Paired Separated Bike Lane
WAVERLY ST	North	Bike Boulevard
WAWARME AV	South	Bike Lane
WEBSTER ST	South	Shared Roadway
WELLS ST	Central	Bike Lane
WEST PRESTON ST	South	Shared Roadway
WEST ST	Central	Bike Boulevard
WESTBOURNE PKWY	Central	Bike Lane
WESTLAND ST	North	Shared Roadway
WESTON ST	North	Shared Roadway
WESTON ST	South	Sidepath
WETHERSFIELD AV	South	1-Way Paired Separated Bike Lane
WHITE ST	South	Shared Roadway
WHITNEY ST	Central	Bike Lane
WOODLAND ST	Central/ North	1-Way Paired Separated Bike Lane
WYLLYS ST	Central	1-Way Paired Separated Bike Lane, partially stripped for bike lane

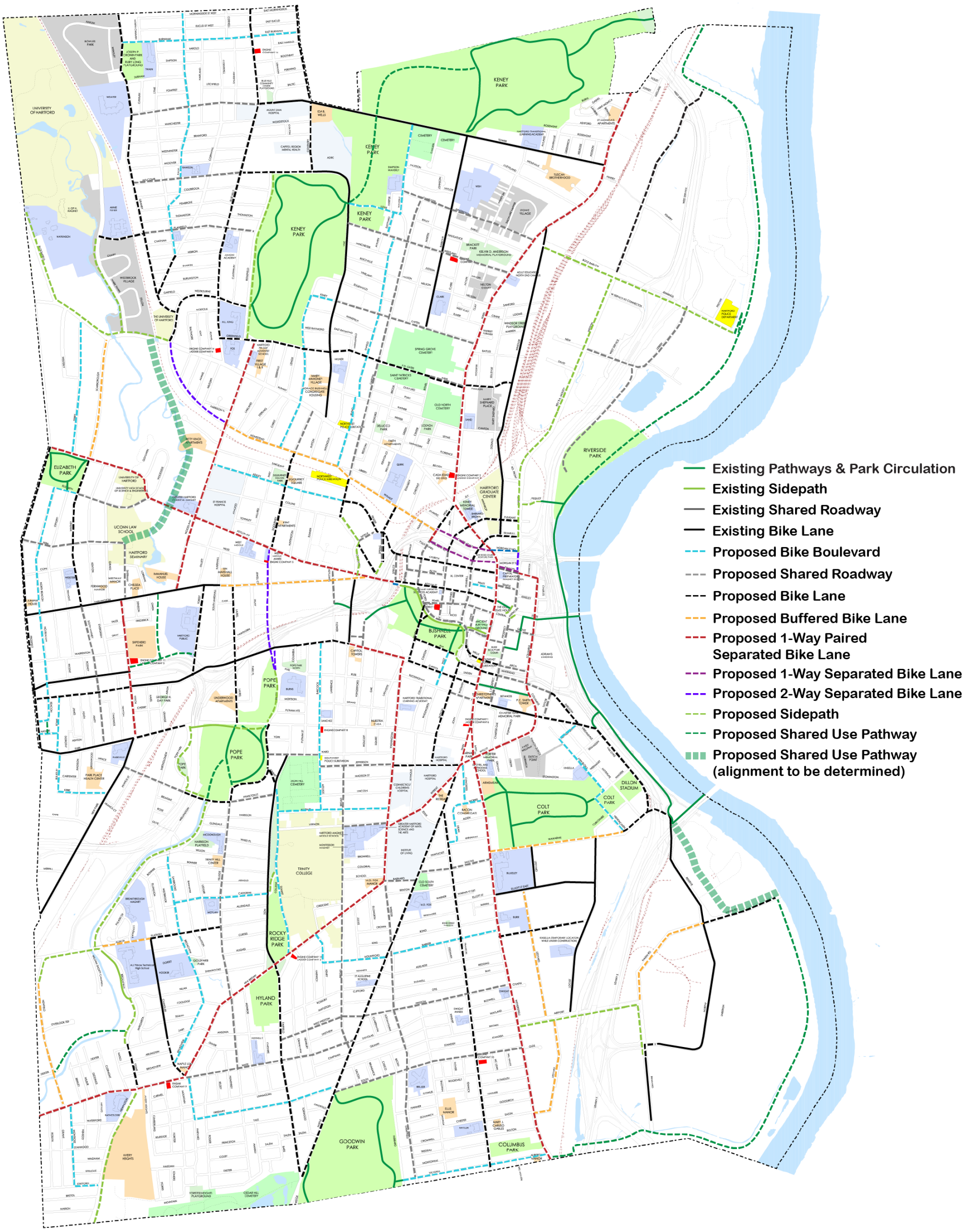


Figure 6-1: Recommended bicycle network

7 IMPLEMENTATION PLAN

7.1 Implementation plan criteria

Projects were ranked on both their benefits and implementability, to develop an overall recommendation for project phasing.

First individual projects were defined: each street that was recommended to include a bike facility was divided into sections depending upon what type of facility was proposed for each section. Some streets had just one type of facility recommended and others had two or more, depending upon how the characteristics of the street changes over its length. The type of facility selected was based on the guidelines and was usually connected to the geometry of the particular section including the number of lanes, right of way width, shoulder conditions, and other characteristics. Each project can be built discretely without limiting what can subsequently be done to either side.

The ranking included two phases, first for overall benefits and the ability to implement, and second, a combined score which assigned phasing based upon benefits and implementability.

All of the proposed facilities were assigned a score based on the two sets of criteria: benefits and implementability. For the overall benefits criteria projects could earn scores between 0 and 24. The highest score achieve by a project was 23 and the lowest was 8. Higher scores were generally earned by longer, more extensive projects that complete key links in the bike network and that would have significant benefits for a large number of cyclists. Lower scores were generally earned by smaller, simpler projects, limited to a specific neighborhood. The general criteria used are shown in Table 16 below

The full evaluation matrix is included in Appendix B.

Table 16: Overall Benefits Criteria

CRITERIA GROUP	CRITERIA	SCORES		
Mobility and Access	Volume of existing or potential bicycle traffic	High	Medium	Low
	Provides access to major bicycle traffic generators	Provides access to areas of high bicycle traffic generation	Moderate access to areas of high bicycle traffic generation	Low access to areas of high bicycle traffic generation
	Closes a significant gap	Closes a gap in an existing bicycle facility or between facilities	Closes a gap in a planned bicycle facility or between planned facilities	Closes a gap connecting facilities with little bicycle traffic
	Equity	Provides access to low income and/or diverse neighborhoods	Provides access to low income and/or diverse neighborhoods	Does not provide access to low income and/or diverse neighborhoods

CRITERIA GROUP	CRITERIA	SCORES		
		along much of its length	along some of its length	
Safety	Improves locations where bicycle crashes have occurred	Bicycle collisions have occurred directly on this route	Bicycle collisions have occurred near this route	No collisions have occurred on this route
	Improves routes with high vehicular traffic volumes	Improves routes with high average daily trips	Improves routes with moderate average daily trips	Improves routes with low average daily trips
Regional Significance	Route has regional significance in the bikeway system	High significance, connects major bicycle facilities and activity centers in surrounding municipalities	Moderate significance, connects some routes and activity centers in surrounding municipalities	Little significance, does not directly connect to activity centers, bicycle trip generation, but is still important in the bikeway system

All of the proposed projects were also assigned a score for ability to implement based on their cost, project complexity, and whether any other challenges to their timely implementation were present. The ability to implement criteria are shown in Table 17 below. These two scores were combined to develop a phasing score of 1 to 4, with those scored with a 1 being near term and a score of 4 being the longest term.

Table 17: Ability to Implement Criteria

CRITERIA GROUP	CRITERIA	SCORING		
Ability to Implement	Roadway able to accommodate bikeways	Roadway can currently accommodate the recommended facility with no construction and/or redesign	Roadway can accommodate the recommended facility with some construction and/or redesign	Roadway will need significant construction and/or redesign to accommodate the recommended facility
	Implementation cost	Low cost project requiring no additional funding	Medium cost project that can be funded through CIP with existing resources	High cost project requiring new grant funding
	Additional study needed	No additional study needed	Feasibility and conceptual design study required	Feasibility study, conceptual design, and environmental study required
	Maintainability	Little or no additional maintenance needed.	Additional maintenance using existing procedures and equipment needed.	Additional maintenance using new procedures or equipment needed.

Additionally, capital costs were developed for each proposed facility. Capital costs were estimated using a simple model based appropriate to a citywide bicycle master plan on a cost per linear foot by project type which was created using IBI's historic experience with bike facilities and verified using FHI's local experience in Hartford. The unit costs assumed were as follows:

- Bike Boulevard - $15.00/lf Assumes cost of traffic calming such as speed humps, painting sharrows, and other signage
- Shared Roadway - $5.00/lf Assumes cost of painting sharrows and other signage
- Bike Lanes - $10.00/lf Assumes cost of pavement markings and signage
- Buffered Bike Lane - $15.00/lf Assumes cost of removing parking, if necessary, and restriping roadway with lane markings and other signage
- 1 Way Paired Separated Bike Lanes (Street Level) - $105.00/lf assumes cost of removing parking, if necessary, restriping roadway with lane markings and other signage, and installing traffic separators (flexible posts, curbs, and/or planters) on both sides of the street.
- 1 Way Paired Separated Bike Lanes (Sidewalk Level) - $300.00/lf (lf cost represents facility length along roadway, not the combined length of bike lanes on each side of street). Assumes relocation of curb or sidewalk to accommodate bike lane and relocation of utility structures as feasible. Includes intersection enhancements necessary to support facility.

- 2 Way Separated Bike Lanes - $50.00/lf assumes cost of removing parking, if necessary, restriping roadway with lane markings and other signage, and installing traffic separators (flexible posts, curbs, and/or planters) on one side of the street to accommodate a bi-directional bike lane.
- 2 Way Separated Bike Lanes (Sidewalk Level) - $200.00/lf assumes relocation of curb or sidewalk to accommodate bike lane and relocation of utility structures as feasible. Includes intersection enhancements necessary to support facility.
- Sidepath - $120/lf assumes the construction of a new 10 foot wide multi-use trail on one side of the street. Actual cost will vary depending upon the need for property acquisition.

Bikeway facility construction costs vary widely depending on a variety of factors. These figures are for project comparison and long term budgeting purposes only and not to establish specific project level construction budgets.

7.2 Project List

The following table (Table 18) lists each project including the street, proposed type of facility, length of the facility, estimated cost, whether the facility is a low stress bikeway that encourages a broader group of people to ride, its score on the general criteria, its score on implementability, and its combined score and recommended phase. Projects that score highest on benefits are shown in green, lowest in red, and those in between in yellow. Projects that tend to score higher for their overall benefits to the program tend to be more complex and longer, but also tend to be more challenging to implement and be recommended in the long term.

Table 18: Project list with criteria scores and ability to implement phase

Street	Proposed Facility	Length (Ft.)	Estimated Facility Cost	Low Stress?	Benefits	Implementability	Combined Score	Phase
AFFLECK ST	Bike Boulevard	2,130	$31,950	X	10	1	6	3
AIRPORT RD	Sidepath	3,100	$372,000	X	16	3	6	3
ALBANY AVE	Sidepath	3,060	$367,200	X	16	3	6	3
ALLEN PL	Bike Boulevard	2,760	$41,400	X	11	1	6	3
ALLYN ST	Shared Roadway	960	$4,800		12	1	5	2
ANN UCCELLO ST	Shared Roadway	1,790	$8,950		15	1	4	1
ANN UCCELLO ST	Bike Lane	260	$2,600		16	2	5	2
ANNAWAN ST	Bike Boulevard	250	$3,750	X	11	1	6	3
ARCH ST	Shared Roadway	730	$3,650		17	1	4	1
ARCH ST	Bike Lane	40	$400		17	2	5	2
ASHLEY ST	Bike Boulevard	3,390	$50,850	X	8	1	6	3
ASYLUM AV	1-Way Paired Separated Bike Lane	8,810	$925,050	X	23	3	4	1
ASYLUM PL	Shared Roadway	290	$1,450		12	1	5	2

Street	Proposed Facility	Length (Ft.)	Estimated Facility Cost	Low Stress?	Benefits	Implementability	Combined Score	Phase
ASYLUM ST	Bike Lane	2,560	$25,600		22	2	3	1
ASYLUM ST	1-Way Paired Separated Bike Lane	670	$70,350	X	22	3	4	1
ATHENEUM SQ NORTH	Shared Roadway	430	$2,150		14	1	5	2
BABCOCK ST	Bike Boulevard	2,070	$31,050	X	11	1	6	3
BARKER ST	Bike Boulevard	2,680	$40,200	X	9	1	6	3
BARNARD ST	Shared Roadway	780	$3,900		13	1	5	2
BEACON ST	Bike Boulevard	2,950	$44,250	X	9	1	6	3
BLOOMFIELD AVE	Sidepath	2,460	$295,200	X	12	3	7	4
BLUE HILLS AVE	Bike Lane	8,450	$84,500		22	2	3	1
BOB STEELE ST	Shared Roadway	660	$3,300		14	1	5	2
BOCE BARLOW WAY	Sidepath	1,850	$222,000	X	12	3	7	4
BRAINARD RD	Buffered Bike Lane	620	$9,300		11	2	7	4
BRAINARD RD	Bike Lane	310	$3,100		11	2	7	4
BRAINARD RD	Sidepath	1,090	$130,800	X	11	3	8	4

Street	Proposed Facility	Length (Ft.)	Estimated Facility Cost	Low Stress?	Benefits	Implementability	Combined Score	Phase
BROAD ST	Shared Roadway	7,170	$35,850		14	1	5	2
BROADVIEW TER	Bike Boulevard	3,540	$53,100	X	9	1	6	3
BROOKFIELD ST	Sidepath	6,190	$742,800	X	16	3	6	3
BUCKINGHAM ST	Shared Roadway	640	$3,200		14	1	5	2
BULKELEY AV	Bike Boulevard	960	$14,400	X	11	1	6	3
BURNHAM ST	Bike Boulevard	3,220	$48,300	X	10	1	6	3
CAMPFIELD AV	Shared Roadway	5,920	$29,600		11	1	6	3
CAPEN ST	Shared Roadway	3,620	$18,100		13	1	5	2
CAPITOL AV	1-Way Paired Separated Bike Lane	1,460	$153,300	X	19	3	5	2
CAPITOL AV	Bike Lane	2,390	$23,900		18	3	5	2
CAPITOL AV	Bike Lane	1,300	$13,000		18	3	5	2
CATHERINE ST	Bike Boulevard	2,360	$35,400	X	11	1	6	3
CHANDLER ST	Bike Lane	1,090	$10,900		11	2	7	4
CHAPEL ST NORTH	1-Way Paired	1,160	$121,800	X	15	3	6	3

Street	Proposed Facility	Length (Ft.)	Estimated Facility Cost	Low Stress?	Benefits	Implementability	Combined Score	Phase
	Separated Bike Lane							
CHAPEL ST SOUTH	1-Way Paired Separated Bike Lane	1,780	$186,900	X	15	3	6	3
CHARLOTTE ST	Shared Roadway	1,290	$6,450		13	1	5	2
CHARTER OAK AV	Bike Lane	1,500	$15,000		16	2	5	2
CHURCH ST	Shared Roadway	2,560	$12,800		15	1	4	1
COGSWELL ST	Sidepath	810	$97,200	X	17	3	6	3
COLLEGE TER	Sidepath	610	$73,200	X	15	3	6	3
COLUMBUS BLVD	1-Way Paired Separated Bike Lane	4,470	$469,350	X	22	3	4	1
CONGRESS ST	Bike Boulevard	1,000	$15,000	X	11	1	6	3
CORNWALL ST	Bike Lane	1,070	$10,700		12	2	6	3
COVENTRY ST	Bike Lane	3,840	$38,400		11	2	7	4
CRRA SITE	Shared Use Pathway	3,800	$456,000	X	12	3	4	1
DEAN ST	Bike Boulevard	900	$13,500	X	10	1	6	3

Street	Proposed Facility	Length (Ft.)	Estimated Facility Cost	Low Stress?	Benefits	Implementability	Combined Score	Phase
EAST BURNHAM ST	Bike Boulevard	1,180	$17,700	X	10	1	6	3
EASTFORD ST	Bike Boulevard	600	$9,000	X	10	1	6	3
EDGEWOOD ST	Bike Boulevard	3,960	$59,400	X	12	1	5	2
EDWARDS ST	Bike Lane	750	$7,500		12	2	6	3
ELIZABETH ST	Shared Roadway	1,930	$9,650		9	1	6	3
ELIZABETH ST	Bike Boulevard	580	$8,700	X	9	1	6	3
ELM ST	Bike Lane	1,720	$17,200		12	3	7	4
ENFIELD ST	Bike Boulevard	4,130	$61,950	X	11	1	6	3
F D OATES AV	Bike Lane	1,310	$13,100		13	2	6	3
FAIRFIELD AV	Bike Lane	5,360	$53,600		11	2	7	4
FARMINGTON AV	Buffered Bike Lane	3,770	$56,550		23	2	3	1
FERN ST	Shared Roadway	2,120	$10,600		9	1	6	3
FLATBUSH AV	Buffered Bike Lane	1,270	$19,050		14	2	6	3
FLATBUSH AV	Bike Lane	1,770	$17,700		14	2	6	3

Street	Proposed Facility	Length (Ft.)	Estimated Facility Cost	Low Stress?	Benefits	Implementability	Combined Score	Phase
FLATBUSH AV	Sidepath	1,430	$171,600	X	13	3	7	4
FLOWER ST	Shared Roadway	670	$3,350		12	1	5	2
FORD ST	Shared Roadway	480	$2,400		16	1	4	1
FOREST ST	Bike Lane	2,290	$22,900		13	2	6	3
FRANKLIN AV	Bike Lane	8,890	$88,900		18	2	4	1
FRASER PL	Bike Lane	1,250	$12,500		13	2	6	3
FREEMAN ST	Bike Boulevard	3,620	$54,300	X	9	1	6	3
GARDEN ST	Shared Roadway	7,150	$35,750		12	1	5	2
GARDEN ST	Bike Lane	2,030	$20,300		14	2	6	3
GARDEN ST	Sidepath	750	$90,000	X	12	3	7	4
GOLD ST	Shared Roadway	490	$2,450		15	1	4	1
GRANBY ST	Bike Lane	7,870	$78,700		13	2	6	3
GREENFIELD ST	Bike Lane	3,770	$37,700		14	2	6	3
HAMILTON ST	Shared Roadway	2,710	$13,550		12	1	5	2

Street	Proposed Facility	Length (Ft.)	Estimated Facility Cost	Low Stress?	Benefits	Implementability	Combined Score	Phase
HAMILTON ST	Bike Lane	1,230	$12,300		13	2	6	3
HARTFORD HIGH SCHOOL	Shared Use Pathway	3,200	$384,000	X	12	2	4	1
HARVARD ST	Bike Boulevard	1,050	$15,750	X	10	1	6	3
HAYNES ST	Shared Roadway	330	$1,650		13	1	5	2
HENDRICXSEN AVE	Bike Boulevard	1,000	$15,000	X	9	1	5	2
HENRY ST	Bike Boulevard	780	$11,700	X	10	1	6	3
HIGH ST	2-Way Separated Bike Lane	270	$13,500	X	15	2	3	1
HIGH ST	Bike Lane	800	$8,000		15	2	5	2
HIGH ST	Shared Roadway	1,240	$6,200		14	1	5	2
HILLSIDE AV	Shared Roadway	6,730	$33,650		14	1	5	2
HILLSIDE AV	Bike Lane	340	$3,400		11	2	7	4
HOLCOMB ST	Shared Roadway	2,700	$13,500		11	1	6	3
HOLCOMB ST	Bike Lane	1,810	$18,100		11	2	7	4
HOMESTEAD AV	Buffered Bike Lane	3,370	$50,550		20	2	4	1

Street	Proposed Facility	Length (Ft.)	Estimated Facility Cost	Low Stress?	Benefits	Implementability	Combined Score	Phase
HOMESTEAD AV	1-Way Paired Separated Bike Lane	2,620	$275,100	X	18	3	5	2
HUDSON ST	Shared Roadway	2,660	$13,300		13	1	5	2
IRVING ST	Bike Boulevard	1,790	$26,850	X	12	1	5	2
JEFFERSON ST	Shared Roadway	1,830	$9,150		15	1	4	1
JEFFERSON ST	Bike Lane	1,730	$17,300		15	3	6	3
JENNINGS ROAD	Sidepath	3,100	$372,000	X	15	3	6	3
JEWELL ST	Shared Roadway	1,680	$8,400		16	1	4	1
KENEY PARK	Shared Use Pathway	5,000	$600,000	X	12	3	4	1
KENEY TER	Bike Boulevard	660	$9,900	X	11	1	6	3
KENSINGTON ST	Shared Roadway	2,200	$11,000		14	1	5	2
KIBBE ST	Bike Boulevard	1,250	$18,750	X	11	1	6	3
LAUREL ST	Bike Lane	3,440	$34,400		12	2	6	3
LEDYARD ST	Buffered Bike Lane	6,010	$90,150		11	2	7	4
LEIBERT RD	Shared Roadway	2,670	$13,350		10	1	6	3

Street	Proposed Facility	Length (Ft.)	Estimated Facility Cost	Low Stress?	Benefits	Implementability	Combined Score	Phase
LEWIS ST	Shared Roadway	570	$2,850		12	1	5	2
LOVE LA	Bike Boulevard	1,350	$20,250	X	10	1	6	3
LYME ST	Bike Boulevard	1,210	$18,150	X	9	1	6	3
MAHL AV	Bike Lane	880	$8,800		13	2	6	3
MAIN ST	1-Way Paired Separated Bike Lane	16,650	$1,748,250	X	18	3	5	2
MAPLE AV	Bike Lane	10,240	$102,400		18	2	4	1
MAPLE AV	1-Way Paired Separated Bike Lane	270	$28,350	X	17	3	6	3
MARK TWAIN DR	Sidepath	2,600	$312,000	X	14	3	7	4
MARKET ST	Shared Roadway	950	$4,750		17	1	4	1
MARKET ST	2-Way Separated Bike Lane	540	$27,000	X	20	3	5	2
MARKET ST	Sidepath	1,270	$152,400	X	18	3	5	2
MASSEK ST	Bike Boulevard	300	$4,500	X	9	1	5	2
MAXIM RD	Buffered Bike Lane	2,210	$33,150		12	2	6	3

Street	Proposed Facility	Length (Ft.)	Estimated Facility Cost	Low Stress?	Benefits	Implementability	Combined Score	Phase
MAXIM RD	Bike Lane	1,890	$18,900		11	2	7	4
MEADOW ST	Bike Lane	2,260	$22,600		11	2	7	4
MONTROSE ST	Bike Boulevard	2,040	$30,600	X	9	1	6	3
MORGAN ST	1-Way Paired Separated Bike Lane	1,080	$113,400	X	16	3	6	3
MORRIS ST	Bike Boulevard	730	$10,950	X	9	1	6	3
MOUNTFORD ST	Bike Boulevard	1,590	$23,850	X	9	1	6	3
MURPHY RD	Bike Lane	300	$3,000		11	2	7	4
MYRTLE ST	Bike Lane	780	$7,800		15	2	5	2
MYRTLE ST	Shared Roadway	600	$3,000		13	1	5	2
NEPAQUASH ST	Bike Boulevard	500	$7,500	X	9	1	5	2
NEW BRITAIN AV	1-Way Paired Separated Bike Lane	10,930	$1,147,650	X	17	3	6	3
NEWFIELD AV	Buffered Bike Lane	3,870	$58,050		12	2	6	3
NEWINGTON AV	Sidepath	3,520	$422,400	X	14	3	7	4

Street	Proposed Facility	Length (Ft.)	Estimated Facility Cost	Low Stress?	Benefits	Implementability	Combined Score	Phase
NORTH BEACON ST	Bike Boulevard	3,220	$48,300	X	9	1	6	3
NORTH BRANCH PARK RIVER	Shared Use Pathway	5,500	$660,000	X	12	4	4	1
NORTH CT RIVERFRONT	Shared Use Pathway	14,400	$1,728,000	X	12	2	4	1
PALM ST	Bike Boulevard	5,040	$75,600	X	9	1	6	3
PARK ST	Bike Lane	1,310	$13,100		17	2	5	2
PARK ST	Sidepath	750	$90,000	X	15	3	6	3
PARK TER	Bike Lane	2,240	$22,400		16	2	5	2
PARK TER	Sidepath	1,250	$150,000	X	15	3	6	3
PEARL ST	Shared Roadway	1,800	$9,000		16	1	4	1
PEQUOT ST	Sidepath	510	$61,200	X	16	3	6	3
PLAINFIELD ST	Bike Lane	1,080	$10,800		14	2	6	3
PLAINFIELD ST	Shared Roadway	2,070	$10,350		9	1	6	3
PLEASANT ST	Bike Lane	1,840	$18,400		13	2	6	3
POPE PARK DR	Shared Use Pathway	860	$103,200	X	12	3	7	4

Street	Proposed Facility	Length (Ft.)	Estimated Facility Cost	Low Stress?	Benefits	Implementability	Combined Score	Phase
POPE PARK HWY NO 4	Sidepath	1,850	$222,000	X	12	3	7	4
PRATT ST	Bike Boulevard	660	$9,900	X	10	1	6	3
PRESTON ST	Shared Roadway	3,720	$18,600		10	1	6	3
PROSPECT AV	Bike Lane	7,540	$75,400		9	2	7	4
PROSPECT ST	Shared Roadway	1,540	$7,700		15	1	4	1
PULASKI CIR	Sidepath	500	$60,000	X	12	3	7	4
RESERVE RD	Bike Lane	550	$5,500		12	2	6	3
RETREAT AV	1-Way Paired Separated Bike Lane	2,160	$226,800	X	19	3	5	2
REV R A MOODY OVERPASS	Sidepath	4,220	$506,400	X	13	3	7	4
RIDGEFIELD ST	Sidepath	4,250	$510,000	X	16	3	6	3
RIVERSIDE PARK	Bike Lane	3,060	$30,600		10	2	7	4
ROWE AV	Bike Boulevard	1,420	$21,300	X	11	1	6	3
SAYBROOKE ST	Bike Boulevard	2,050	$30,750	X	11	1	6	3
SCARBOROUGH ST	Buffered Bike Lane	6,410	$96,150		11	2	7	4

Street	Proposed Facility	Length (Ft.)	Estimated Facility Cost	Low Stress?	Benefits	Implementability	Combined Score	Phase
SHELDON ST	Bike Lane	1,480	$14,800		15	2	5	2
SHELDON ST	Shared Roadway	1,430	$7,150		13	1	5	2
SHERMAN ST	Shared Roadway	1,870	$9,350		10	1	6	3
SHULTAS PL	Shared Roadway	1,800	$9,000		13	1	5	2
SIGOURNEY ST	2-Way Separated Bike Lane	4,320	$216,000	X	15	3	3	1
SIGOURNEY ST	Bike Lane	2,480	$24,800		16	2	5	2
SIGOURNEY ST	Shared Roadway	1,150	$5,750		14	1	5	2
SISSON AV	1-Way Paired Separated Bike Lane	3,460	$363,300	X	16	3	6	3
SOUTH CT RIVERFRONT	Shared Use Pathway	11,650	$1,398,000	X	12	3	4	1
SOUTH PROSPECT ST	Shared Roadway	770	$3,850		14	1	5	2
SOUTH ST	Shared Roadway	4,810	$24,050		9	1	6	3
SOUTH WHITNEY ST	Shared Roadway	3,470	$17,350		12	1	5	2
SPRING ST	Sidepath	300	$36,000	X	15	3	6	3
SPRING ST	Bike Lane	820	$8,200		14	2	6	3

Street	Proposed Facility	Length (Ft.)	Estimated Facility Cost	Low Stress?	Benefits	Implementability	Combined Score	Phase
SPRUCE ST	Shared Roadway	690	$3,450		14	1	5	2
STAFFORD ST	Bike Boulevard	640	$9,600	X	9	1	6	3
STONE ST	Bike Lane	1,090	$10,900		14	2	6	3
SUMMIT ST	Bike Lane	430	$4,300		12	2	6	3
SUMMIT ST	Bike Boulevard	4,320	$64,800	X	11	1	6	3
TALCOTT ST	1-Way Paired Separated Bike Lane	1,060	$111,300	X	20	3	5	2
TAYLOR ST	Shared Roadway	640	$3,200		12	1	5	2
TEMPLE ST	Shared Roadway	540	$2,700		13	1	5	2
TERRY RD	Bike Boulevard	3,380	$50,700	X	9	1	6	3
TOWER AV	Shared Roadway	3,190	$15,950		11	1	6	3
TRINITY CUT OFF	Bike Lane	320	$3,200		14	2	6	3
TRINITY ST	Bike Lane	1,490	$14,900		15	2	5	2
TRUMBULL ST	Shared Roadway	4,690	$23,450		17	1	4	1
TRUMBULL ST	Bike Lane	1,460	$14,600		15	2	5	2

Street	Proposed Facility	Length (Ft.)	Estimated Facility Cost	Low Stress?	Benefits	Implementability	Combined Score	Phase
UNION PL	Shared Roadway	710	$3,550		13	1	5	2
VAN BLOCK AVE	Bike Boulevard	1,700	$25,500	X	9	1	5	2
VAN DYKE AV	Bike Lane	2,990	$29,900		15	2	5	2
VERNON ST	Shared Roadway	1,100	$5,500		14	1	5	2
VICTORIA RD	Bike Boulevard	3,660	$54,900	X	9	1	6	3
WALNUT ST	Buffered Bike Lane	2,560	$38,400		19	2	4	1
WARD ST	Shared Roadway	1,260	$6,300		11	1	6	3
WASHINGTON ST	1-Way Paired Separated Bike Lane	5,660	$594,300	X	17	3	6	3
WAVERLY ST	Bike Boulevard	2,280	$34,200	X	10	1	6	3
WAWARME AV	Bike Lane	4,170	$41,700		15	2	5	2
WEBSTER ST	Shared Roadway	1,550	$7,750		14	1	5	2
WELLS ST	Bike Lane	1,000	$10,000		17	2	5	2
WEST PRESTON ST	Shared Roadway	2,180	$10,900		9	1	6	3
WEST ST	Bike Boulevard	940	$14,100	X	11	1	6	3

Street	Proposed Facility	Length (Ft.)	Estimated Facility Cost	Low Stress?	Benefits	Implementability	Combined Score	Phase
WESTBOURNE PKWY	Bike Lane	5,660	$56,600		16	2	5	2
WESTLAND ST	Shared Roadway	4,280	$21,400		11	1	6	3
WESTON ST	Sidepath	2,000	$240,000	X	15	3	6	3
WESTON ST	Shared Roadway	720	$3,600		10	1	6	3
WETHERSFIELD AV	1-Way Paired Separated Bike Lane	10,190	$1,069,950	X	19	3	5	2
WHITE ST	Shared Roadway	4,400	$22,000		11	1	6	3
WHITNEY ST	Bike Lane	3,760	$37,600		13	2	6	3
WOODLAND ST	1-Way Paired Separated Bike Lane	6,570	$689,850	X	16	3	6	3
WYLLYS ST	1-Way Paired Separated Bike Lane, partially stripped for bike lane	2,350	$246,750	X	19	3	5	2

8 EVALUATION PLAN

This report section documents the recommended evaluation strategy for the implementation of the Hartford Bicycle Master Plan. The evaluation strategy contains a set of performance measures and metrics that will be used by the City to evaluate the impacts on local and regional travel from implementing the Hartford Bicycle Master Plan.

8.1 Background

8.1.1 APPLYING PERFORMANCE MEASURES IN BICYCLE PLANNING AND PROGRAMMING

Applying performance measures in bicycle planning and programming is an important tool for local jurisdictions. It enables them to measure the effectiveness of a project or strategy in meeting community goals based on quantitative data. It also helps local jurisdictions prioritize projects and evaluate their progress over time. The following list describes the ways performance measures can be applied to bicycle planning and programming:

- Prioritizing projects
- Demonstrating value of bicycle projects to elected officials
- Improving the decision making process for infrastructure investments with data-driven choices
- Providing information to engage and garner support for bicycle infrastructure investments
- Tracking the success of new bicycle infrastructure
- Benchmarking and establishing usage baselines for bicycling

8.1.2 RESOURCES USED TO DEVELOP THE EVALUATION STRATEGY

A number of resources were used to develop the evaluation strategy for the *Hartford Bicycle Master Plan*. These resources can be referred to for additional information regarding the performance measures and metrics. The following resources were used:

- California Department of Transportation (Caltrans), Toward an Active California State Bicycle & Pedestrian Plan Performance Measures Technical Report, 2017.
- Fehr and Peers, Active Transportation Performance Measures, 2015.
- Federal Highway Administration (FHWA), Guidebook for Developing Pedestrian & Bicycle Performance Measures, 2016.

8.2 EVALUATION STRATEGY

The evaluation strategy for the Hartford Bicycle Master Plan includes a set of performance measures and metrics used to evaluate the impact of implementing the Plan. Each performance measure is useful for evaluating different components of the bicycle network. These performance measures include safety, facility use, network quality, connectivity and access, and financial investment. For each performance measure, a performance metric was identified. Performance metrics represent the quantitative data that will be collected and evaluated. These performance metrics include collisions/crash statistics, user counts, gap closure, facility miles, access to destinations, and expenditures on bicycle infrastructure. TABLE 19 summarizes the performance measures and metrics for the evaluation strategy as well as the corresponding data collection method for each. Detailed discussion on the performance measures and metrics are described in the subsequent sections.

TABLE 19: EVALUATION STRATEGY

PERFORMANCE MEASURE	METRIC	DATA COLLECTION METHOD
Safety	Collisions / Crash Statistics	Collisions data / crash statistics can be obtained from the University of Connecticut (UCONN) Connecticut Crash Data Repository and Hartford Police Department statistics. https://www.ctcrash.uconn.edu/
Facility Use	User Counts	Facility user counts can be collected using bicycle counters or from the Hartford Police Department traffic surveillance cameras.
Network Quality	Gap Closure	Gap closures can be identified using ArcGIS.
	Facility Miles	Facility miles can be calculated using ArcGIS.
Connectivity and Access	Access to Community Destinations (shopping centers, recreational areas, parks, etc.)	Access to community destinations can be determined using ArcGIS.
Financial Investment	Expenditures on Bicycle Infrastructure	Capital Improvement Plan, Annual Budgets

8.2.1 PERFORMANCE MEASURES AND METRICS

Five performance measures were identified for the evaluation strategy of the Hartford Bicycle Master Plan. Each performance measure evaluates a different component of the bicycle network and is useful in evaluating the impacts of implementing the Hartford Bicycle Master Plan on local and regional travel. Performance metrics were also identified for each performance measure as illustrated in TABLE 19. The following sections describe each performance measure and their corresponding performance metric, as well as the data collection method for each metric.

8.2.1.1 SAFETY

Safety as a performance measure provides information on the well-being of bicyclists on a given bicycle network. The safer a bicycle facility is, the more likely it will be used. Safety as a performance measure provides information on frequency and location of injuries and collisions which may be useful in determining locations that require infrastructure improvements. This evaluation strategy recommends using collisions/crash statistics as a performance metric for evaluating safety.

COLLISIONS AND CRASH STATISTICS

Collisions and crash statistics provide information on the safety of a bicycle facility as well as the overall bicycle network. Data sources such as the UCONN Connecticut Crash Data Repository can be used to collect data on collisions involving bicyclists. The query tools within the UCONN Connecticut Crash Data Repository allow users to request collision data based on a variety of factors such as crash type, level of severity (e.g. fatal vs. non-fatal), intersection crashes, bicyclist-involved crashes, and more. The query tools also allow users to request data for a specific time period. Data from the Hartford Police Department can also be used. When analyzing existing conditions for collisions, it is recommended that data is collected for a period of three years or

more to ensure the analysis captures an appropriate amount of data under various seasonal conditions that may impact levels of bicycling activity.

8.2.1.2 FACILITY USE

Facility use as a performance measure provides information on the number of bicyclists that utilize a given bicycle facility as well the overall bicycle network. Facility use as performance measure can provide local jurisdictions with initial high level observations of the overall bicycle network quality. Low levels of facility use can provide insight into issues with safety, network quality, or connectivity. This evaluation strategy recommends using user counts as a performance metric for evaluating facility use.

USER COUNTS

User counts provide information on the frequency a bicycle facility or network is used by bicyclists. They also help to provide insight into other conditions impacting bicycling activity such as safety, connectivity, and access to destinations. User count data can be collected in a variety of ways. This evaluation strategy recommends that user count data be collected through on-street bicycle counters and/or via police surveillance cameras installed along roadways.

There are a variety of technology options for on-street bicycle counters. These options include pneumatic tubes, inductive loops, active infrared detectors, and passive infrared detectors. The Federal Highway Administration (FHWA) has published a report on pedestrian and bicycle data collection, which discusses the available technologies for on-street bicycle counters and their associated opportunities and constraints. The various opportunities and constraints discussed include costs, accuracy, ability to count both bicycles and pedestrians, and safety hazards. The City of Hartford should consider these factors when deciding which technology to utilize.

In addition to on-street bicycle counters, user counts can also be conducted via police surveillance cameras. When requesting data from police surveillance cameras, City staff should specify information such as time frame, time of day, AM/PM peak hours, corridor, and corridor limits (start and end locations). By providing specific data requests, City staff will reduce the amount of time spent on filtering and formatting data for analysis.

8.2.1.3 NETWORK QUALITY

Network quality as a performance measure provides information on elements that impact the quality and attractiveness of the bicycling environment. Simply providing bicycle infrastructure does not always increase bicycle activity within a community. Higher quality infrastructure, which enhances the attractiveness of biking, considers elements such as roadway conditions, accessibility, connectivity, and others. This evaluation strategy recommends using gap closures and facility miles as performance metrics for evaluating network quality.

GAP CLOSURES

Gap closures provide information on the overall bicycle network quality and can also be used to prioritize bicycle projects. A more complete and comprehensive bicycle network typically encourages more levels of bicycling activity. Data collection for gap closures will involve utilizing ArcGIS software to first identify the locations of existing bicycle facilities and then to determine the locations of gaps in the network. This information can be regularly collected as City staff updates their GIS shapefiles for existing bicycle facilities.

FACILITY MILES

Bicycle facility miles provide information on the overall bicycle network quality and can be used to establish a benchmark and monitor progress in the implementation of the Hartford Bicycle Master Plan. Data collection for facility miles will involve utilizing ArcGIS software to calculate the number of existing bicycle facility miles. This information can be regularly collected as City staff updates their GIS shapefiles for existing bicycle facilities.

8.2.1.4 CONNECTIVITY AND ACCESS

Connectivity and access as a performance measure provides information on the ability to use bicycling as mode of transportation to access goods, services, and key destinations. By providing access to key destinations, a bicycle network can enhance the attractiveness of biking as an alternative travel mode. This evaluation strategy recommends using access to community destinations as a performance metric for evaluating connectivity and access.

ACCESS TO COMMUNITY DESTINATIONS

Access to community destinations provides information on the bicycle network's connectivity and access. Data collection for this metric will involve utilizing ArcGIS software to determine the proximity of a bicycle facility to various community destinations such as schools, shopping centers, transit stops/stations, parks, employment centers, and other key points of interest. These activity centers were identified in ArcGIS as part of the development of the Hartford Bicycle Master Plan facility map.

8.2.1.5 FINANCIAL INVESTMENT

Financial investment as a performance measure provides information on a local jurisdiction's commitment to improving bicycle infrastructure and bicycling conditions, as well as information on the amount of money spent on bicycle projects. Tracking financial investments in bicycle infrastructure can also be useful in identifying locations where infrastructure investments have been made, which can consequently help address any equity issues in infrastructure investments. This evaluation strategy recommends using expenditures on bicycle infrastructure as a performance metric for evaluating financial investment.

EXPENDITURES ON BICYCLE INFRASTRUCTURE

Expenditures on bicycle infrastructure provide information on financial investment in the overall bicycle network. It can be used to establish a benchmark and monitor progress in the implementation of the Bicycle Master Plan. Expenditure data can be collected by reviewing the City's Capital Improvement Plan and Annual Budgets.

APPENDICES

APPENDIX A: COMMENTS FROM PUBLIC MEETINGS

APENDIX A-1: Public meeting, 2/20/2018

Feedback recorded was received in the meeting, via input forms, and via email before and after the meeting.

General Feedback:

- Will plan allow for contra flow bike lanes on one way streets?
- Will you convert 1 way streets to 2 way for traffic calming?
- Can you put a “rumble strip” along the buffer between a buffered bike lane and the travel lane so motorists know when they are beginning to stray toward the bike lane
- Much interest in bike Boulevards
- The side streets near St. Francis that don’t allow for through traffic work well for bicyclists.
- Engage the NRZs and neighborhood residents on the question of streets that could be bike boulevards. Reach out to younger people in neighborhoods.
- You should map the speed hump streets to know where we already have a network of quiet streets
- Perhaps there are some very low volume streets that could be closed to all traffic, except bicycles and pedestrians.
- Maybe bike boulevards could be achieved with rush hour restrictions on traffic for some streets.
- A striped bike lane should not be considered if the speeds on a road are 30 mph or higher, a physical barrier is needed.
- There should be separated or buffered bike lanes on every major artery in Hartford
- Bikes should not be allowed on sidewalks in the City
- Desire for protected bike lanes, with physical barriers.
- Wherever a bike lane ends, the road should be signed to be clear that bikes are able to continue operating and the road is a shared street
- Streets surrounding parks should not allow parking, in the same way we do not allow parking in front of schools. The parking lanes could then become bike lanes.
- More bike parking racks are needed
- Consider homeless generators to be bike trip generators. Also don’t focus on high income neighborhoods. Give extra consideration to neighborhoods with low income and lowest car ownership. Breweries and some bars should be considered generators. Large grocery stores and drug stores. Lime bike deployment should provide input to this question
- Need more traffic law enforcement in the City
- When bike share starts, we need more enforcement of bike law. Might be good to get this going in the schools
- Hartford should develop a safe biking course. Bicyclists who violate traffic law should have to take this course. It should also be offered in middle and high schools
- Education about the rules of the road is essential, the City should develop a bicycling website that covers this. Education is as important as facilities

Preferred bike roads (low speed, low volume):

- Terry Road
- Westerly terrace
- Mark Twain drive
- Lorraine
- Forest street
- Niles street
- Elizabeth street
- Huntington
- Lawrence/Flower
- Babcock
- Cut through Poper Park to laurel
- Brookfield
- Newton
- Saybrook
- Hamilton
- Sargent
- Ward
- Many low speed/traffic roads in west end
- Capitol and Farmington, where there are bike lanes

Trail ideas:

- Extend the bike path north from the Boat House to the Windsor path that links to the Bissell Bridge. (*answer – we have funding to begin to build this extension)*
- Better marking of trails is needed – there are pillars on the bridge connecting Founders Bridge to Constitution Plaza (over Columbus Blvd) that are not visible at night, during commute times
- The rail viaduct may provide an opportunity for a Hartford High Line.
- Extend the Riverwalk southward
- Provide a trail that will link with the busway trail that ends in Newington. This could be done making use of the South branch trail (existing and proposed)
- Link Pope Park via bike path to the Founders Bridge
- Extend the East Coast Greenway north to Bloomfield. Could Keney Park be part of this extension?
- The riverpath is important to people who live at Colt
- Handicapped/bike access to constitution Plaza needs to be improved
- In busy parks, for example, Bushnell, Pope, there should be separate bike paths to keep fast moving bicyclists separate from pedestrians

APENDIX A-2: Public meeting, 6/18/2018

Feedback recorded was received in the meeting, via input forms, and via email before and after the meeting.

General Feedback:

- Where arterial corridors change in character (from retail to residential) the bike plan recommendations should change also. Particularly this is an issue on Farmington, franklin, Maple, North Main and Sisson/New Park. Coordinate better with zoning
- Where is the distinction between ideal and acceptable facilities made in the plan?
- The City needs to commit to a willingness to acquire ROW where land is available without taking buildings. This could include cooperative efforts with property owners up to condemnation
- The City should have a serious commitment to reducing automobile dependency – closing lanes or even whole blocks.
- Take advantage of the upcoming I84 plan
- We sacrifice too much right of way to the storage of privately owned vehicles
- How is the City coordinating with neighboring towns?
- Would the City consider using a shallow rumble strip type separation for buffered bike lanes? Would warn vehicles that they are going into the bike lane, and would make maintenance easier. Information from Portland on this concept: https://bikeportland.org/2016/01/08/first-look-new-172178
- Shared roadway is not a bike facility. We should not include this category of facility.
- Drop buffered bike lanes in favor of separated bike lanes. Paint won't stop anyone from going into the bike lane.
- The plan should be bolder. We can dream bigger, better
- Placing parking between travel lane and bike lane is a strategy that we should try, especially on arterials.
- It is difficult to distinguish the different colors of lines on the map – perhaps add some patterns?
- What will happen next?
- I support the plan
- Need more bike racks in the City
- Signage for bike routes is important – both for designation and PR
- Need a bike map
- Need to work on connecting bike routes first
- Please consider lowest income neighborhoods with priority and also streets near neighborhood schools
- Should be a citizen oversight committee for implementation
- Priority ought to be neighborhood scale connections, not city streets
- Would like to see more accessibility for pedi cabs in plan
- Need broad outreach, not just NRZs. Need to engage kids
- Need demonstration projects so people can see what a high level facility can be.

Feedback Specific to Bike Plan

- Main street from South green through downtown should have bicycle facilities, fully separated, either at street level or at sidewalk level. Should have protected intersections, bus boarding islands and median refuge islands
- Seems to be too little planned for downtown, at least one north south and one east west route should be included, not just shared roadways. Main and asylum seem widest and best. Shared roadways in downtown will not accommodate the 8 to 80 cyclist
- All of Pulaski Circle needs to be rebuilt to accommodate cyclists on a side path around the entire circle
- Turning left from Main street (heading south) to Charter Oak Ave is very difficult today

- Prospect Street – seems to be sufficient width for bike lanes if parking is modified or lane layout
- Bike lane needed on Albany avenue
- Washington between Park Street and Capitol Ave really needs bike facility.
- Hudson from Bushnell Park to Jefferson – couldn't this have bike lanes? Would provide access to Hartford Hospital
- Windsor Ave – this would be an ideal place for a 2 way protected bike lane on the east side
- Farmington Ave should have higher level facility recommended. Is Asylum going to be the preferred route. Farmington seems to be the better choice between the two because of all the places it connects and retail it serves.
- Homestead Ave – seems you could easily put a 2 way separated bike path on the south side
- Brookfield street – sidepath on Park River side of Brookfield is an excellent idea
- Sigourney Street – would like to see the recommended 2 way separated bike lane extended northward to Homestead Ave
- Granby street has enough width for a buffered or protected bike lane. Would be a good facility to serve Weaver high school. Plan shows simple bike lane
- Access from Constitution Plaza level to Riverfront, other than elevator, is needed
- Two roads recommended for bike boulevards lie on CTtransit route 76 (Ashley street and Palm street.) The technical guide does not address transit in bike boulevards, but seems transit would make the roads seem less comfortable for cyclists. Can this be addressed? Maybe these roads need to be recharacterized? (*NOTE from sfry – we should overlay transit routes on our bike boulevards. I think the commenter is correct, they do not belong together.)*
- Blue Hills neighborhood needs bike facilities
- Good slow speed low volume roads for biking today – Wawarme, Van Dyke, Jefferson, Wethersfield. Park St is high volume but low speed. Also Niles, Lorraine, Westerly Terrace and Terry Road
- Improved facilities on Capitol avenue are important for bike commuters
- Park street, Park terrace to Main – should be shared street and lower speed limit
- Needs to be some management of bikes through Bushnell Park and Riverfront paths. Bikes and pedestrians do not work well together when ped volumes are high. Look at what U of Minnesota in Minneapolis has done with painted bike lanes near ped high volume areas
- Should push harder on Prospect Avenue
- Ramp from Park terrace to Russ Street should be a bike boulevard
- Lorraine – 2 way bike lane (with contra flow lane) could make sense
- Wawarme could have a 2 way separated bike lane, on north side, separated from traffic by parking, on north side of road

Related Feedback not Specific to the Bike Plan

- Change Pulaski Circle to a proper roundabout
- Need crosswalk at the intersection of Edgewood St and Albany (this will be addressed by streetscape project)
- Put a fee on surface parking lots, phase in over 5 years to increase development and fund complete streets projects

APPENDIX B: IMPLEMENATION MATRIX

#	Street	Proposed Facility	Length (Ft.)	Estimated Facility Cost	Low Stress ?	Implementability	Bicycle traffic	Access	Gap closure	Equity	Bicycle crash location	High traffic volume	Reg'l asset	Utility Benefits	Recommended Phase
1	AFFLECK ST	Bike Boulevard	2,130	$31,950	X	1	1	1	1	1	3	1	1	10	3
2	AIRPORT RD	Sidepath	3,100	$372,000	X	3	1	2	1	1	2	1	1	16	3
3	ALBANY AVE	Sidepath	3,060	$367,200	X	3	2	2	1	3	2	1	1	16	3
4	ALLEN PL	Bike Boulevard	2,760	$41,400	X	1	2	2	1	2	1	3	3	11	3
5	ALLYN ST	Shared Roadway	960	$4,800		1	1	2	1	3	2	3	1	12	2
6	ANN UCCELLO ST	Bike Lane	260	$2,600		1	1	1	1	2	3	1	1	15	1
7	ANN UCCELLO ST	Shared Roadway	1,790	$8,950		1	2	2	1	2	2	1	1	16	2
8	ANNAWAN ST	Bike Boulevard	250	$3,750	X	1	3	3	1	2	2	2	1	11	3
9	ARCH ST	Bike Lane	40	$400		2	1	1	1	2	1	1	1	17	1
10	ARCH ST	Shared Roadway	730	$3,650		1	3	3	1	2	2	2	1	17	2
11	ASHLEY ST	Bike Boulevard	3,390	$50,850	X	1	1	1	1	3	2	1	1	8	3
12	ASYLUM AV	1-Way Paired Separated Bike Lane	8,810	$925,050	X	3	2	2	2	2	2	3	1	23	1
13	ASYLUM PL	Shared Roadway	290	$1,450		1	3	3	3	2	1	3	1	12	2
14	ASYLUM ST	1-Way Paired Separated Bike Lane	670	$70,350	X	3	2	2	2	2	3	3	1	22	1
15	ASYLUM ST	Bike Lane	2,560	$25,600		2	2	2	2	2	2	3	3	22	1
16	ATHENEUM SQ NORTH	Shared Roadway	430	$2,150		1	3	3	3	2	1	3	1	14	2
17	BABCOCK ST	Bike Boulevard	2,070	$31,050	X	1	1	1	1	1	1	1	1	11	3

#	Street	Proposed Facility	Length (Ft.)	Estimated Facility Cost	Low Stress ?	Implementability	Bicycle traffic	Access	Gap closure	Equity	Bicycle crash location	High traffic volume	Reg'l asset	Utility Benefits	Recommended Phase
18	BARKER ST	Bike Boulevard	2,680	$40,200	X	1	3	3	3	3	3	3	3	9	3
19	BARNARD ST	Shared Roadway	780	$3,900		1	2	2	1	2	1	2	1	13	2
20	BEACON ST	Bike Boulevard	2,950	$44,250	X	1	3	3	3	3	2	3	3	9	3
21	BLOOMFIELD AVE	Sidepath	2,460	$295,200	X	3	2	2	1	3	3	1	1	12	4
22	BLUE HILLS AVE	Bike Lane	8,450	$84,500		1	3	3	3	3	2	3	3	22	1
23	BOB STEELE ST	Shared Roadway	660	$3,300		1	3	3	1	2	2	1	1	14	2
24	BOCE BARLOW WAY	Sidepath	1,850	$222,000	X	3	2	2	2	2	2	3	1	12	4
25	BRAINARD RD	Bike Lane	310	$3,100		3	1	1	1	2	2	1	1	11	4
26	BRAINARD RD	Buffered Bike Lane	620	$9,300		2	1	1	1	2	1	2	1	11	4
27	BRAINARD RD	Sidepath	1,090	$130,800	X	1	1	1	1	2	3	1	1	11	4
28	BROAD ST	Shared Roadway	7,170	$35,850		1	1	1	1	2	1	1	1	14	2
29	BROADVIEW TER	Bike Boulevard	3,540	$53,100	X	1	2	2	1	2	2	2	1	9	3
30	BROOKFIELD ST	Sidepath	6,190	$742,800	X	3	2	2	1	2	3	2	1	16	3
31	BUCKINGHAM ST	Shared Roadway	640	$3,200		1	1	1	1	1	2	1	1	14	2
32	BULKELEY AV	Bike Boulevard	960	$14,400	X	1	1	1	1	1	1	2	3	11	3
33	BURNHAM ST	Bike Boulevard	3,220	$48,300	X	1	3	3	3	3	1	3	3	10	3
34	CAMPFIELD AV	Shared Roadway	5,920	$29,600		1	3	3	1	2	2	1	1	11	3
35	CAPEN ST	Shared Roadway	3,620	$18,100		1	1	1	2	2	1	3	1	13	2
36	CAPITOL AV	1-Way Paired Separated Bike Lane	1,460	$153,300	X	3	1	1	1	2	1	1	1	19	2
37	CAPITOL AV	Bike Lane	1,300	$13,000		2	2	2	1	2	1	2	1	18	2
38	CAPITOL AV	Bike Lane	2,390	$23,900		3	2	2	1	2	2	1	1	18	2

#	Street	Proposed Facility	Length (Ft.)	Estimated Facility Cost	Low Stress ?	Implementability	Bicycle traffic	Access	Gap closure	Equity	Bicycle crash location	High traffic volume	Reg'l asset	Utility Benefits	Recommended Phase
39	CATHERINE ST	Bike Boulevard	2,360	$35,400	X	1	1	1	1	2	1	2	1	11	3
40	CHANDLER ST	Bike Lane	1,090	$10,900		2	1	1	1	1	2	1	1	11	4
41	CHAPEL ST NORTH	1-Way Paired Separated Bike Lane	1,160	$121,800	X	3	2	2	1	2	2	1	1	15	3
42	CHAPEL ST SOUTH	1-Way Paired Separated Bike Lane	1,780	$186,900	X	3	2	2	1	2	2	3	1	15	3
43	CHARLOTTE ST	Shared Roadway	1,290	$6,450		1	1	1	1	2	1	2	1	13	2
44	CHARTER OAK AV	Bike Lane	1,500	$15,000		1	1	1	1	2	1	2	1	16	2
45	CHURCH ST	Shared Roadway	2,560	$12,800		1	2	2	1	3	2	2	1	15	1
46	COGSWELL ST	Sidepath	810	$97,200	X	2	1	1	1	2	2	1	1	17	3
47	COLLEGE TER	Sidepath	610	$73,200	X	2	1	1	1	2	2	1	1	15	3
48	COLUMBUS BLVD	1-Way Paired Separated Bike Lane	4,470	$469,350	X	3	2	2	1	2	2	3	1	22	1
49	CONGRESS ST	Bike Boulevard	1,000	$15,000	X	1	1	1	1	2	1	1	1	11	3
50	CORNWALL ST	Bike Lane	1,070	$10,700		1	1	2	2	3	2	1	3	12	3
51	COVENTRY ST	Bike Lane	3,840	$38,400		1	2	2	1	2	3	2	1	11	4
52	CRRA SITE	Shared Use Pathway	3,800	$456,000	X	3	3	3	1	2	2	2	1	12	1
53	DEAN ST	Bike Boulevard	900	$13,500	X	1	1	1	1	3	2	1	1	10	3
54	EAST BURNHAM ST	Bike Boulevard	1,180	$17,700	X	1	1	1	1	3	1	1	1	10	3
55	EASTFORD ST	Bike Boulevard	600	$9,000	X	1	1	1	1	3	1	2	1	10	3
56	EDGEWOOD ST	Bike Boulevard	3,960	$59,400	X	1	2	2	1	3	2	1	1	12	2
57	EDWARDS ST	Bike Lane	750	$7,500		1	3	3	2	2	3	3	2	12	3
58	ELIZABETH ST	Bike Boulevard	580	$8,700	X	1	3	3	2	2	3	3	1	9	3

#	Street	Proposed Facility	Length (Ft.)	Estimated Facility Cost	Low Stress ?	Implementability	Bicycle traffic	Access	Gap closure	Equity	Bicycle crash location	High traffic volume	Reg'l asset	Utility Benefits	Recommended Phase
59	ELIZABETH ST	Shared Roadway	1,930	$9,650		1	3	3	2	2	3	3	1	9	3
60	ELM ST	Bike Lane	1,720	$17,200		2	1	1	1	2	1	1	1	12	4
61	ENFIELD ST	Bike Boulevard	4,130	$61,950	X	1	1	1	1	3	2	1	1	11	3
62	F D OATES AV	Bike Lane	1,310	$13,100		1	1	1	1	3	1	1	1	13	3
63	FAIRFIELD AV	Bike Lane	5,360	$53,600		2	2	2	1	3	2	3	2	11	4
64	FARMINGTON AV	Buffered Bike Lane	3,770	$56,550		2	2	2	1	3	2	2	1	23	1
65	FERN ST	Shared Roadway	2,120	$10,600		1	1	3	1	2	2	3	1	9	3
66	FLATBUSH AV	Bike Lane	1,770	$17,700		3	1	1	1	2	1	1	1	14	3
67	FLATBUSH AV	Buffered Bike Lane	1,270	$19,050		2	2	2	1	3	2	2	1	14	3
68	FLATBUSH AV	Sidepath	1,430	$171,600	X	1	1	3	1	2	2	3	1	13	4
69	FLOWER ST	Shared Roadway	670	$3,350		1	2	2	1	3	1	2	1	12	2
70	FORD ST	Shared Roadway	480	$2,400		1	2	2	2	2	3	2	1	16	1
71	FOREST ST	Bike Lane	2,290	$22,900		1	3	3	1	2	2	2	1	13	3
72	FRANKLIN AV	Bike Lane	8,890	$88,900		2	2	2	1	3	2	2	1	18	1
73	FRASER PL	Bike Lane	1,250	$12,500		1	2	2	1	2	3	2	2	13	3
74	FREEMAN ST	Bike Boulevard	3,620	$54,300	X	1	2	2	1	1	2	1	3	9	3
75	GARDEN ST	Bike Lane	2,030	$20,300		3	2	2	1	3	1	1	1	12	2
76	GARDEN ST	Shared Roadway	7,150	$35,750		1	3	3	3	2	3	3	3	14	3
77	GARDEN ST	Sidepath	750	$90,000	X	1	1	1	1	2	3	1	1	12	4
78	GOLD ST	Shared Roadway	490	$2,450		1	1	1	1	3	2	1	1	15	1
79	GRANBY ST	Bike Lane	7,870	$78,700		2	3	3	1	2	2	3	1	13	3
80	GREENFIELD ST	Bike Lane	3,770	$37,700		1	1	1	1	3	1	1	1	14	3
81	HAMILTON ST	Bike Lane	1,230	$12,300		1	1	1	1	2	2	1	1	12	2
82	HAMILTON ST	Shared Roadway	2,710	$13,550		1	1	1	1	2	2	1	1	13	3

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83	HARTFORD HIGH SCHOOL	Shared Use Pathway	3,200	$384,000	X	2	1	1	1	2	1	1	1	12	1
84	HARVARD ST	Bike Boulevard	1,050	$15,750	X	1	1	1	1	3	1	1	1	10	3
85	HAYNES ST	Shared Roadway	330	$1,650		1	1	1	1	3	1	1	1	13	2
86	HENDRICXSEN AVE	Bike Boulevard	1,000	$15,000	X	1	1	1	1	2	3	1	1	9	2
87	HENRY ST	Bike Boulevard	780	$11,700	X	1	1	1	1	3	3	1	1	10	3
88	HIGH ST	2-Way Separated Bike Lane	270	$13,500	X	2	2	2	1	3	2	2	1	15	1
89	HIGH ST	Bike Lane	800	$8,000		2	2	2	2	2	2	1	2	15	2
90	HIGH ST	Shared Roadway	1,240	$6,200		2	2	2	1	3	1	1	1	14	2
91	HILLSIDE AV	Bike Lane	340	$3,400		2	1	1	1	2	1	1	1	14	2
92	HILLSIDE AV	Shared Roadway	6,730	$33,650		1	1	2	1	2	2	1	1	11	4
93	HOLCOMB ST	Bike Lane	1,810	$18,100		2	2	2	1	2	2	2	1	11	3
94	HOLCOMB ST	Shared Roadway	2,700	$13,500		1	1	1	1	1	2	1	1	11	4
95	HOMESTEAD AV	1-Way Paired Separated Bike Lane	2,620	$275,100	X	3	1	1	1	3	2	1	1	20	1
96	HOMESTEAD AV	Buffered Bike Lane	3,370	$50,550		2	1	1	1	2	2	1	1	18	2
97	HUDSON ST	Shared Roadway	2,660	$13,300		1	1	1	1	1	2	1	1	13	2
98	IRVING ST	Bike Boulevard	1,790	$26,850	X	1	1	2	1	2	3	1	1	12	2
99	JEFFERSON ST	Bike Lane	1,730	$17,300		2	1	1	1	2	2	1	1	15	1
100	JEFFERSON ST	Shared Roadway	1,830	$9,150		1	1	1	1	3	2	1	1	15	3
101	JENNINGS ROAD	Sidepath	3,100	$372,000	X	3	1	1	1	3	2	1	1	15	3

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102	JEWELL ST	Shared Roadway	1,680	$8,400		1	1	2	1	3	2	1	1	16	1
103	KENEY PARK	Shared Use Pathway	5,000	$600,000	X	3	1	2	1	3	1	1	1	12	1
104	KENEY TER	Bike Boulevard	660	$9,900	X	1	1	2	1	2	1	1	1	11	3
105	KENSINGTON ST	Shared Roadway	2,200	$11,000		1	3	3	3	3	3	3	3	14	2
106	KIBBE ST	Bike Boulevard	1,250	$18,750	X	1	1	1	1	1	2	1	1	11	3
107	LAUREL ST	Bike Lane	3,440	$34,400		2	1	1	1	2	2	1	1	12	3
108	LEDYARD ST	Buffered Bike Lane	6,010	$90,150		2	1	1	1	3	1	1	1	11	4
109	LEIBERT RD	Shared Roadway	2,670	$13,350		1	1	2	1	2	1	3	2	10	3
110	LEWIS ST	Shared Roadway	570	$2,850		1	1	2	1	2	1	3	2	12	2
111	LOVE LA	Bike Boulevard	1,350	$20,250	X	1	1	2	1	2	1	3	2	10	3
112	LYME ST	Bike Boulevard	1,210	$18,150	X	1	2	2	1	2	1	2	1	9	3
113	MAHL AV	Bike Lane	880	$8,800		1	3	3	1	2	2	3	1	13	3
114	MAIN ST	1-Way Paired Separated Bike Lane	16,650	$1,748,250	X	3	3	3	2	2	2	3	3	18	2
115	MAPLE AV	1-Way Paired Separated Bike Lane	270	$28,350	X	3	1	2	1	2	3	1	1	18	1
116	MAPLE AV	Bike Lane	10,240	$102,400		2	1	1	1	1	1	2	1	17	3
117	MARK TWAIN DR	Sidepath	2,600	$312,000	X	3	2	3	1	2	2	1	1	14	4
118	MARKET ST	2-Way Separated Bike Lane	540	$27,000	X	3	1	1	1	1	2	1	1	17	1
119	MARKET ST	Shared Roadway	950	$4,750		3	1	1	1	3	1	2	1	20	2
120	MARKET ST	Sidepath	1,270	$152,400	X	1	1	2	1	3	2	1	1	18	2

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121	MASSEK ST	Bike Boulevard	300	$4,500	X	1	1	1	1	1	1	1	3	9	2
122	MAXIM RD	Bike Lane	1,890	$18,900		2	2	3	1	2	3	2	1	12	3
123	MAXIM RD	Buffered Bike Lane	2,210	$33,150		1	2	2	2	3	2	3	3	11	4
124	MEADOW ST	Bike Lane	2,260	$22,600		1	1	2	1	2	3	1	1	11	4
125	MONTROSE ST	Bike Boulevard	2,040	$30,600	X	1	1	1	1	2	1	1	1	9	3
126	MORGAN ST	1-Way Paired Separated Bike Lane	1,080	$113,400	X	3	2	2	1	2	3	1	1	16	3
127	MORRIS ST	Bike Boulevard	730	$10,950	X	1	1	2	1	2	3	2	1	9	3
128	MOUNTFORD ST	Bike Boulevard	1,590	$23,850	X	1	2	2	1	1	3	1	1	9	3
129	MURPHY RD	Bike Lane	300	$3,000		1	1	2	1	2	1	2	1	11	4
130	MYRTLE ST	Bike Lane	780	$7,800		1	3	3	1	2	2	2	1	15	2
131	MYRTLE ST	Shared Roadway	600	$3,000		1	1	2	1	2	1	2	2	13	2
132	NEPAQUASH ST	Bike Boulevard	500	$7,500	X	1	1	1	1	2	1	3	3	9	2
133	NEW BRITAIN AV	1-Way Paired Separated Bike Lane	10,930	$1,147,650	X	3	2	2	1	2	3	2	1	17	3
134	NEWFIELD AV	Buffered Bike Lane	3,870	$58,050		2	1	1	1	2	2	1	1	12	3
135	NEWINGTON AV	Sidepath	3,520	$422,400	X	3	2	2	1	2	2	3	1	14	4
136	NORTH BEACON ST	Bike Boulevard	3,220	$48,300	X	1	1	2	1	3	2	2	1	9	3
137	NORTH BRANCH PARK RIVER	Shared Use Pathway	5,500	$660,000	X	4	2	2	1	3	3	3	3	12	1
138	NORTH CT RIVERFRONT	Shared Use Pathway	14,400	$1,728,000	X	2	1	1	1	2	1	2	2	12	1
139	PALM ST	Bike Boulevard	5,040	$75,600	X	1	1	1	1	3	2	2	1	9	3
140	PARK ST	Bike Lane	1,310	$13,100		1	1	1	1	3	2	2	1	17	2

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141	PARK ST	Sidepath	750	$90,000	X	1	1	1	1	2	2	1	1	15	3
142	PARK TER	Bike Lane	2,240	$22,400		3	3	3	2	2	2	3	1	16	2
143	PARK TER	Sidepath	1,250	$150,000	X	1	1	1	1	3	1	1	1	15	3
144	PEARL ST	Shared Roadway	1,800	$9,000		1	2	3	1	2	2	1	1	16	1
145	PEQUOT ST	Sidepath	510	$61,200	X	2	1	1	1	2	2	2	1	16	3
146	PLAINFIELD ST	Bike Lane	1,080	$10,800		1	1	1	1	2	1	1	1	14	3
147	PLAINFIELD ST	Shared Roadway	2,070	$10,350		1	1	1	1	3	1	1	1	9	3
148	PLEASANT ST	Bike Lane	1,840	$18,400		2	2	2	1	3	3	3	3	13	3
149	POPE PARK DR	Shared Use Pathway	860	$103,200	X	2	1	1	1	2	2	3	1	12	4
150	POPE PARK HWY NO 4	Sidepath	1,850	$222,000	X	3	2	3	1	2	2	1	1	12	4
151	PRATT ST	Bike Boulevard	660	$9,900	X	1	2	2	1	2	2	3	1	10	3
152	PRESTON ST	Shared Roadway	3,720	$18,600		1	2	2	1	2	2	3	1	10	3
153	PROSPECT AV	Bike Lane	7,540	$75,400		2	2	2	1	3	2	2	1	9	4
154	PROSPECT ST	Shared Roadway	1,540	$7,700		1	2	2	1	2	2	3	1	15	1
155	PULASKI CIR	Sidepath	500	$60,000	X	1	1	1	1	2	2	2	1	12	4
156	RESERVE RD	Bike Lane	550	$5,500		2	1	1	1	1	2	1	1	12	3
157	RETREAT AV	1-Way Paired Separated Bike Lane	2,160	$226,800	X	3	1	1	1	2	1	1	1	19	2
158	REV R A MOODY OVERPASS	Sidepath	4,220	$506,400	X	3	2	2	1	2	3	1	1	13	4
159	RIDGEFIELD ST	Sidepath	4,250	$510,000	X	3	2	2	1	3	2	2	1	16	3
160	RIVERSIDE PARK	Bike Lane	3,060	$30,600		2	1	1	1	3	2	1	1	10	4
161	ROWE AV	Bike Boulevard	1,420	$21,300	X	1	2	2	1	3	2	2	1	11	3
162	SAYBROOKE ST	Bike Boulevard	2,050	$30,750	X	1	1	1	1	3	1	2	1	11	3

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163	SCARBOROUGH ST	Buffered Bike Lane	6,410	$96,150		2	1	1	1	3	2	1	1	11	4
164	SHELDON ST	Bike Lane	1,480	$14,800		1	2	2	1	2	1	1	1	15	2
165	SHELDON ST	Shared Roadway	1,430	$7,150		1	2	1	2	3	3	3	3	13	2
166	SHERMAN ST	Shared Roadway	1,870	$9,350		1	2	2	2	3	3	3	3	10	3
167	SHULTAS PL	Shared Roadway	1,800	$9,000		1	1	2	1	3	3	1	1	13	2
168	SIGOURNEY ST	2-Way Separated Bike Lane	4,320	$216,000	X	2	2	2	1	1	2	2	1	15	1
169	SIGOURNEY ST	Bike Lane	2,480	$24,800		3	1	1	1	1	2	1	1	16	2
170	SIGOURNEY ST	Shared Roadway	1,150	$5,750		1	1	1	1	3	3	1	1	14	2
171	SISSON AV	1-Way Paired Separated Bike Lane	3,460	$363,300	X	3	1	1	1	2	1	1	1	16	3
172	SOUTH CT RIVERFRONT	Shared Use Pathway	11,650	$1,398,000	X	3	2	2	1	2	3	3	2	12	1
173	SOUTH PROSPECT ST	Shared Roadway	770	$3,850		1	2	2	1	2	3	3	1	14	2
174	SOUTH ST	Shared Roadway	4,810	$24,050		1	2	2	1	3	3	2	1	9	3
175	SOUTH WHITNEY ST	Shared Roadway	3,470	$17,350		1	2	2	1	2	2	3	1	12	2
176	SPRING ST	Bike Lane	820	$8,200		2	2	2	1	2	3	1	1	15	3
177	SPRING ST	Sidepath	300	$36,000	X	1	3	3	1	2	2	3	1	14	3
178	SPRUCE ST	Shared Roadway	690	$3,450		1	1	1	1	2	2	1	1	14	2
179	STAFFORD ST	Bike Boulevard	640	$9,600	X	1	1	1	1	3	2	1	1	9	3
180	STONE ST	Bike Lane	1,090	$10,900		1	1	2	3	3	1	2	1	14	3
181	SUMMIT ST	Bike Boulevard	4,320	$64,800	X	1	1	1	1	3	2	1	1	12	3
182	SUMMIT ST	Bike Lane	430	$4,300		1	1	2	1	3	2	1	1	11	3

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183	TALCOTT ST	1-Way Paired Separated Bike Lane	1,060	$111,300	X	3	2	2	2	3	3	3	2	20	2
184	TAYLOR ST	Shared Roadway	640	$3,200		1	1	2	1	1	1	1	1	12	2
185	TEMPLE ST	Shared Roadway	540	$2,700		1	1	1	1	2	1	2	1	13	2
186	TERRY RD	Bike Boulevard	3,380	$50,700	X	1	1	3	1	2	2	1	1	9	3
187	TOWER AV	Shared Roadway	3,190	$15,950		1	1	1	1	3	1	1	1	11	3
188	TRINITY CUT OFF	Bike Lane	320	$3,200		1	1	1	1	2	1	1	1	14	3
189	TRINITY ST	Bike Lane	1,490	$14,900		1	1	2	1	3	2	1	1	15	2
190	TRUMBULL ST	Bike Lane	1,460	$14,600		1	2	2	1	3	2	3	3	17	1
191	TRUMBULL ST	Shared Roadway	4,690	$23,450		1	2	2	1	2	3	3	3	15	2
192	UNION PL	Shared Roadway	710	$3,550		1	2	2	1	2	3	3	3	13	2
193	VAN BLOCK AVE	Bike Boulevard	1,700	$25,500	X	1	2	2	1	2	3	3	3	9	2
194	VAN DYKE AV	Bike Lane	2,990	$29,900		1	1	2	1	3	2	1	1	15	2
195	VERNON ST	Shared Roadway	1,100	$5,500		1	3	3	3	2	2	3	3	14	2
196	VICTORIA RD	Bike Boulevard	3,660	$54,900	X	1	3	3	1	2	2	2	3	9	3
197	WALNUT ST	Buffered Bike Lane	2,560	$38,400		2	2	2	1	2	3	1	1	19	1
198	WARD ST	Shared Roadway	1,260	$6,300		1	2	2	2	2	2	3	3	11	3
199	WASHINGTON ST	1-Way Paired Separated Bike Lane	5,660	$594,300	X	3	1	1	1	3	1	2	1	17	3
200	WAVERLY ST	Bike Boulevard	2,280	$34,200	X	1	1	1	1	2	1	1	1	10	3
201	WAWARME AV	Bike Lane	4,170	$41,700		1	1	1	2	2	1	1	1	15	2

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202	WEBSTER ST	Shared Roadway	1,550	$7,750		1	1	1	2	2	1	2	1	14	2
203	WELLS ST	Bike Lane	1,000	$10,000		1	1	1	1	2	1	1	1	17	2
204	WEST PRESTON ST	Shared Roadway	2,180	$10,900		1	1	1	1	2	1	1	1	9	3
205	WEST ST	Bike Boulevard	940	$14,100	X	1	2	2	2	2	1	3	2	11	3
206	WESTBOURNE PKWY	Bike Lane	5,660	$56,600		1	1	1	1	2	1	1	1	16	2
207	WESTLAND ST	Shared Roadway	4,280	$21,400		1	1	1	1	2	1	1	1	11	3
208	WESTON ST	Shared Roadway	720	$3,600		1	1	1	1	2	1	2	1	15	3
209	WESTON ST	Sidepath	2,000	$240,000	X	3	2	2	1	2	3	3	2	10	3
210	WETHERSFIELD AV	1-Way Paired Separated Bike Lane	10,190	$1,069,950	X	3	1	1	1	3	1	1	1	19	2
211	WHITE ST	Shared Roadway	4,400	$22,000		1	2	2	1	2	2	2	1	11	3
212	WHITNEY ST	Bike Lane	3,760	$37,600		1	1	2	1	2	3	2	1	13	3
213	WOODLAND ST	1-Way Paired Separated Bike Lane	6,570	$689,850	X	3	2	2	1	2	2	2	1	16	3
214	WYLLYS ST	1-Way Paired Separated Bike Lane, partially stripped for bike lane	2,350	$246,750	X	3	2	2	1	2	2	2	2	19	2